EG&G

EG&G INVESTIGATION
INTO THE
CHEMICAL AGENT DISCHARGE
AT THE
TOOELE CHEMICAL AGENT DISPOSAL FACILITY

May 15-26, 2000

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EG&G Investigation Team

Date: June 9, 2000

EG&G

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Executive Summary

On May 8, 2000, 18 milligrams of chemical munitions GB agent was released from the Tooele Chemical Agent Disposal Facility (TOCDF) common stack. The U. S. Army classified this as a limited area problem and the U. S. Department of Health & Human services (DHHS), Center for Disease Control and Prevention (CDC) conducted a worst case evaluation that determined that the maximum possible exposure to GB agent at ground level was less than one percent of the DHHS acceptable safe level for such an exposure to the general public. EG&G dispatched a four person corporate investigation team to evaluate the circumstances that led to the release and provide recommendations for corrective action to improve performance.

The Deactivation Furnace System (DFS) uses a kiln to process metallic items that are contaminated with chemical agents developing a solid waste stream of sanitized metal. Two feed chutes are installed, one for projectiles and one for rockets. An automated feed system chops rockets into segments and feeds those segments into the kiln through an upper slide gate and a lower tipping gate in the chute. The kiln is normally maintained at a temperature range of 900° F to 1,500° F using one fuel gas burner fed air from a single combustion air blower (CAB). Metal parts are moved to a high temperature conveyor by an auger system in the kiln and subsequently loaded into a transport bin after thermal processing. Residual chemical agent is burned in the kiln and in the Afterburner. Flue gases exit the kiln and are drawn to the Afterburner through a cyclonic separator. The Afterburner normally maintains a temperature of 2,100° F using two gas burners fed air from two CABs.

The Pollution Abatement System (PAS) cools the flue gas and removes acidic particulate matter. Flue gases are drawn from the Afterburner through a quench tower where the gas temperature is decreased to approximately 250° F, through a venturi separator to remove particulate, through a scrubber where the majority of particulates are removed, then through a demister where entrained moisture is removed. A Kurz flow meter is installed between the scrubber and the demister to measure flue gas flow rate, provide low flow alarms and trigger protective actions. Flue gases are drawn through a butterfly flow control valve by two high volume Induced Draft (ID) fans in series that discharge into the common stack. Three other furnace systems also discharge into the stack. Automatic Continuous Air Monitoring Systems (ACAMS) sensors are located in each flue gas line leading to the stack. The stack is also equipped with a double redundant ACAMS (station 701). The DFS sensor is 702. On the evening of the occurrence, both 701 and 702 sensors indicated the release of agent on two separate occasions. These releases were confirmed by Depot Area Air Monitoring System (DAAMS) tube samples.

There were two related root causes of this event. First, the performance of a non-normal procedure to establish the plant conditions to support an Explosive Containment Room (ECR) B entry. The purpose of the entry was to clean out the DFS feed chute and clear a lower tipping gate malfunction. The resulting plant condition established a vacuum in the DFS furnace and PAS systems relative to the agent contaminated ECR B and allowed a flow of chemical agent into the DFS and PAS. Second, the DFS Operator's actions to recover from the upset conditions were not effective and actually caused an increased vacuum and higher flow in the DFS/PAS systems. The DFS operator was newly certified and inexperienced and did not demonstrate the required level of operating skills and understanding of plant dynamics and component control interrelationships in manual and automatic control to manage the difficult recovery.

There were two direct causes for the agent release. First, the loss of Afterburner temperature to a level of approximately 1,160° F and a less than adequate agent residence time (under 2 seconds) caused by excessive flow in the DFS/PAS system. These conditions prevented the system from destroying chemical agent by incineration. Second, although the clean liquor system is not an engineering control to destroy agent but rather is designed to remove acid gases from flue gases, the operator's mistaken termination of clean liquor flow in response to a low sump condition removed the damping effect of clean liquor circulation on flue gas flow in the scrubber and coincidental ability of the clean liquor to absorb low levels of chemical agent.

Significant contributing causes that led to the direct causes included:

- The necessity for more detailed, comprehensive and thorough guidelines in the procedures to establish the conditions for the DPE entry, recovery from the entry and recovery procedures from bottle up: (**NOTE:** "Bottling Up" means turning off the Induced Draft (ID) fans, shutting the ID damper and turning off the Combustion Air Burners).

- Malfunction of the Kurz Meter caused by high moisture entrainment in the flue gases in turn caused by high system flow resulted in a low flow signal to the Burner Management System that shut down the burners in the kiln and Afterburner;

- The operators manual initiation of make up feed to the clean liquor system using process water to the mist eliminator spray heads caused additional moisture entrainment in flue gases;

- The lack of awareness of levels of contaminated agent in the ECR B, the balance of differential pressure that kept agent vapors contained there, and the potential for agent vapors to enter the DFS/PAS system during the establishment of conditions for ECR entry and subsequent recovery;

- A plant history of frequent false positive ACAMS alarms;

- The operators and their supervision did not apply conservatism and believe their indications which showed the plant in a "worst" condition leading to a delayed prompt action to bottle up the DFS/PAS system;

- A training program which did not ensure operators and their supervision retained fundamental system knowledge, understanding of plant dynamics and operating proficiency; and

- Miscommunications that prevented the Plant Shift Manager and Control Room Supervisor and senior line management from fully understanding the plant upset condition.

The recommended corrective actions emphasize:

- Increased management involvement in training and operations since the procedures, discussed in Section 2.4, and the practices of shift operators and supervision in implementing these procedures have set up an autonomy of shift management and senior line management is not informed early enough when their help is needed;

- Improvement in the procedures particularly those relating to the entry into the ECR and operating the DFS furnace and PAS;

- An approach to training that uses an on site simulator to develop operator proficiency; makes more frequent and effective use of lessons learned at the site and throughout the chemical weapons demilitarization complex; places more emphasis in on-shift training; and, ensures required knowledge, understanding of dynamics and proficiency are examined, evaluated and upgraded more frequently than required certification intervals;

- A valve operated from the DFS operator console to rapidly isolate the kiln from the Afterburner and PAS as an engineered barrier to mitigate a potential agent release;

- A flow measurement and logic system insensitive to moisture that uses multiple instruments and sensing locations and provides redundant logic input to the burner management system;

- An engineering fix which insures that residence time for the flue gases is not reduced below two seconds without the kiln isolation valve (mentioned above) closed;

- A single Control Room computer control screen schematic showing immediate status of major and critical components and parameters for the entire DFS/PAS system rather than using twelve separate screens;

- And, finally, involvement by EG&G Corporate Headquarters to ensure effective corrective action and continuous operational improvement.

INTRODUCTION

1.0 Background

On May 8, 2000, approximately 18 milligrams of chemical munitions agent was released from the Tooele Chemical Agent Disposal Facility (TOCDF) common stack. The event occurred on night shift (A Team shift) on May 8th. The day shift just before the occurrence (C Team shift) on May 8th had been processing M 56 warheads. The particular lot of M 56 warhead rockets being processed were known to contain "gelled" agent that was difficult to drain. Only the DFS (M 56 rocket destruction line) and Liquid Incinerator (LIC) No. 1 were operating. The Metal Parts Furnace (MPF) and LIC No. 2 were undergoing major maintenance and were off line. The C shift terminated M 56 warhead processing because of a malfunction of the lower "tipper" gate of the DFS feed chute and made preparations to turn the DFS feed chute lower gate malfunction corrective action and related ECR B DPE entry over to the A shift.

1.1 Facility Description

Mission

The mission of the Tooele Chemical Agent Disposal Facility (TOCDF) is to destroy the portion of the nations Chemical Munitions Stockpile that is stored at Deseret Chemical Depot (DCD), approximately 41% of the total stockpile. The stockpile at DCD consists of ton containers, M-55 Rockets, M-56 warheads, artillery rounds, bombs, landmines, mortar rounds and spray tanks.

The TOCDF was built to accomplish the general demilitarization mission. It is designed to receive, unpack, remove and destroy explosive components, remove and destroy chemical agent, and decontaminate metal parts. The facility and equipment are designed to maintain engineering control of all explosives, agent vapors and other harmful components with a minimum risk to workers, the public and the environment.

The mission is accomplished using a variety of demilitarization equipment and four incinerators. These furnaces are the metal parts furnace (MPF), deactivation furnace system (DFS), and liquid incinerators (LIC No. 1, and LIC No. 2). Each of the four furnace systems has a wet Pollution Abatement System (PAS) to cool and chemically treat exhaust gases before they are released to the atmosphere.

General Description of the Deactivation Furnace System (DFS)

The DFS consists of a rotary kiln, a heated discharge conveyor (HDC), a kiln combustion air blower, a blast attenuation duct, a cyclone separator, an Afterburner, an Afterburner combustion air blower, and associated instrumentation and piping. The feed to the DFS comes from the two explosive containment rooms (ECRs), in which various munitions-processing activities take place. Rocket pieces, mines, bursters, boosters, and fuse are fed by gravity from each ECR through a feed chute. Each feed chute is provided with a built-in system of blast gates to meter the munitions pieces to the kiln. ECR-B and the ECR-B DFS feed chute were in use during processing of the M-56 warheads.

The DFS burns drained rockets, landmines, and energetics removed from projectiles in the kiln with the products of combustion flowing through a blast attenuator and cyclone separator to the Afterburner where the gases are thermally treated. Afterburner exhaust gases then flow to the DFS PAS where they are treated for removal of acid gases and particulate materials. The metal parts and other non-combustibles that are discharged from the kiln are further thermally treated in the heated discharge conveyor (HDC) then transferred to the residue handling area (RHA).

General Description of the Wet Pollution Abatement System (PAS)

Each wet PAS consists of a quench tower, venturi scrubber, packed bed scrubber tower, demister, exhaust blower, emergency exhaust blower, various recirculation and transfer pumps, and associated piping and instrumentation. All four of the wet PASs discharge their exhaust gases into one common stack.

High-temperature exhaust gases from the furnace enter the PAS and travel upward through the quench tower in which caustic brine and water sprays cool the gases to near the saturation temperature (approximately 175° F). The gases then travel down through a venturi scrubber that mixes them at high velocity with more caustic brine, removing most of the acid gases and particulates. The gases flow from the venturi upward to a packed bed scrubber, where they again react with a caustic brine solution (clean liquor) to remove the remaining acid gases. The final stage is a demister, which removes H3PO4 mist, metal oxides, and other solid particulates. From the demister vessel, the gases flow through a damper to the exhaust blower, which discharges the gases to the stack. The exhaust blower is also the motive force that pulls the exhaust gases through the furnace and PAS.

Process water is supplied to the quench and scrubber towers to make up for water that is lost by evaporation. Caustic solution is supplied to the venturi scrubber and scrubber tower packed bed to react with acid gases in the exhaust stream. The salts produced are removed from the system by transferring brine to one of four brine storage tanks. After sampling and analysis the brine is then shipped to a licensed & permitted permanent disposal area.

1.2 Team, Scope, Conduct, and Methodology

The EG&G Corporate Investigation Team members were:

- Jack Kersh, Chairman
- Howard Dickson, Member
- Dan Williams, Member
- Stan Duncan, Member

The team was charged with determining the direct, contributing, and root causes for the agent stack emission and providing recommendations for corrective actions. Only one member of the team was familiar with the plant so the TOCDF General Manager generously arranged for a strong support team of TOCDF experts. Their assistance was essential and invaluable in conducting the investigation. The support team personnel from the TOCDF staff were:

- Thomas Kurkjy
- Kelvin Brito
- Scott Winters
- Tom Clark
- Thane Eyre
- Kent Wilson
- Sheila Vance

The support team members were knowledgeable, professional, responsive, and positive.

All TOCDF personnel contacted were responsive and professional. Each person contacted provided the information requested, displayed a positive helpful attitude, and was interested in learning how to prevent similar events.

The team spent the first two days in briefings and plant tours for familiarization. Individual team members assisted by the TOCDF support team conducted programmatic reviews and interviewed several members of the A-shift crew. Also, the team assembled all data relevant to the incident for review. The team used several analytic techniques including Kepner-Tregoe and Management Oversight and Risk Tree (MORT) in the analysis. A short description of each is provided in Appendix B.

2.0 FACTS AND ANALYSIS

2.1 Narrative Facts and Chronology May 8 and 9, 2000

May 8, 2000

16:18 Shift C was on Station in the Plant and Control Room and was processing M56 Rocket Warheads while the Liquid Incineration Furnace (LIC 1) was on stand-by at normal operating temperature and the Metal Parts Furnace (MPF) and (LIC 2) were in an extended outage and therefore completely shutdown. A lower gate malfunction alarm caused an automatic stop feed of M56 Rocket Warhead material because the lower chute tipper gate (102) associated with Explosive Containment Room (ECR) B and DFS would not make the closed limit switch.

17:00 Following Trouble Shooting and initiating a water flush of the chute and cycling of gate 102 from the Control Room, Plant Shift Manager (PSM) and Control Room Supervisor (CRS) decided to delay conduct of a Demilitarization Protective Ensemble (DPE) entry into ECR B until the next shift in order to clear the malfunction and provide adequate time for preparation and facilitate entry.

17:30 With overall Plant Status as depicted above, A shift took turnover from C-shift with DFS Gate 102 in a malfunction state and commenced preparations to clean out the chute and correct the malfunction. The PSM for this shift is one of the two newest certified PSMs and the one with the least former experience on this plant. The Control Room Supervisor on this shift was normally the alternate Control Room Supervisor. The DFS operator had only been certified for 4 months and had not operated the furnace under upset or major transient conditions.

19:15 (about) Completed Pre-Entry Brief. The control room operator (CRO) controlling the DPE entry, the Shift Maintenance Supervisor, the Shift Operations Supervisor and entry personnel attended the pre-brief. The agenda for the DPE entry included correcting the lower gate malfunction, cleaning out of AQS Strainer and conducting PMs. Following successful completion of the entry tasks, it was intended to restart processing of M56 Rocket Warheads.

20:01 DFS Operator starts to make furnace pressure adjustments per the guidance contained in memorandum number OMM-00-05, to Non-Normal Operating Conditions Plan NO: DFS-011-01. This Plan was written for ECR A not ECR B and does not contain all the necessary steps required to complete the task, and the gate references are incorrect. The PSM gave the procedure to the Control Room Supervisor and directed him to get concurrence from the System Engineer, which the CRS obtained.

20:01-15 The DFS Operator commenced furnace and room pressure reconfiguration activities in preparation for the DPE Entry. The actions were carried out through numerous controller set point changes for the venturi and ID damper while the control loops were in an automatic mode of operation.

20:24 The DPE Entry Team entered the ECR B to commence the chute inspection and clean out process. A slight build up of residues were noted in the feed chute and upper and lower gates and a small amount of debris about the size of a coffee can was noted in the chute. The residue and debris was washed down the feed chute and subsequently into the kiln resulting in minor furnace pressure instability and cooling.

21:29 The clean out was successful allowing the lower tipping gate (102) to fully close and clear the alarm; whereupon, the entry team commenced AQS Strainer cleanout using SOP-112: ECR Housekeeping Procedure.

21:30 DFS Gate 104 closed for final time by DFS operator.

21:37 The entry team completed the strainer cleanout and placed the strainer waste in a container that they left on the upper slide gate (MMS Gate 104) and made preparations for departure of ECR B.

21:39 The entry team departed ECR B and were processed back to the airlocks. The DFS operator restored normal configuration to the ECR B room pressure and Heat Vent & Air Conditioning (HVAC) system.

21:40-45 The DFS operator attempted to restore normal flow and vacuum in the DFS kiln through leaving Venturi Scrubber Plunger and ID Fan Damper in Automatic and inserting incremental set point changes in both related controllers. During the recovery, the initial position of the venturi plunger upon completion of the DP entry would be extremely slow to react to any action of the automatic or manual controls applied in closing the ID fan damper because of the slow control loop tuning. This automatic control condition set up the flow and vacuum conditions resulting in –2" WC in the kiln and –6" in the Afterburner at time 21:55. Although the Control Room Supervisor knew he had an inexperienced DFS operator, he was very busy with other requirements such as Lock Out /Tag Outs and work permits for preventive maintenance to spend much time in oversight. The assistance of another certified DFS operator also was not successful. The Non Normal Procedure, its attached memorandum and the DFS Operators Standing Operating Procedure (SOP-004) did not address DFS recovery from the non-normal condition created by the ECRB entry.

21:46-22:02 The DFS operator took manual control of the Venturi Scrubber Plunger and attempted to restore normal pressures and flows through several control variable (CV) changes, and then placed the control loop back to the automatic mode. In this situation, the differential pressure set point drove the Venturi Scrubber Plunger open again.

21:47 Feed end of the kiln temperature has risen to the normal 960°F temperature and remains above that level for about 17 minutes before again decreasing following burner loss at 22:02.

21:48 DFS operator took manual control of the DFS furnace pressure controller (allowing manual control of the ID fan damper position) in further and continued attempts to restore normal pressures and flows in the DFS furnace and related PAS systems.

21:59 During the restoration process, the clean liquor sump low level alarm came on. In response to this alarm, the operator opened the Scrubber Tower Mist Eliminator Pad water spray in an effort to supplement the normal make up water system. This action contributed to the moisture saturation of the Kurz flow meter.

22:02 While the furnace and related Pollution Abatement System (PAS) systems were still under extremely high vacuum and high flows, a vital (Kurz) flow metering instrument--near the scrubber/mist eliminator outlet-- failed due to high moisture carry over causing a shutdown of the "kiln" burner and two "Afterburner" burners-— a condition referred to as lock–out. The failure of this vital instrument caused the loss of burner management permissives, thereby requiring a 14-minute purge necessary for burner relight. During this process, the Kurz flow malfunctioned intermittently prohibiting the completion of the purge and causing additional cooling to the furnace. The DFS operator continued attempting to restore normal flows and pressures while assisting trouble-shooting efforts including implementing the work order process and also working with maintenance personnel on this vital flow measurement instrument. See Appendix B, Figure 1 for flow history and analysis.

22:02:58 Upon burner lock-out, as a Burner Management System Function, CAB AFB1 and AFB2 go to "high fire" (i.e. 5,000 + CFM) in an auto purge. This purge results in reducing negative pressure in kiln and Afterburner to almost zero "WC".

22:05 CAB AFB1 and AFB2 go to <1,400 CFM by operator intervention and AFB pressure returns to –6 " WC. Kiln remains in the range of –1.5 to –2 " WC (-3.0 to-3.5 on PIT 168). Pressures remain as such until 22:30. [**Note:** PIT 168 Pressures will be shown in parentheses in the remainder of the Narrative Chronology. PIT 168 senses in the kiln discharge duct. The kiln and Afterburner pressure indicators were pegged at –2" and –6" WC.]

22:07 The DFS operator shut off the Scrubber Tower Mist Eliminator Pad water spray.

22:30 CAB AFB1 and AFB2 go to 5,000+ CFM. AFB and kiln pressures again approach zero values. Purge continues until 22:49. Kiln temperature that was already around 400° F degrees is reduced to 312° F (TIT-020) and 368° F (TIT-182) by 22:49. Afterburner temperatures went from 1,534° F (TIT –092) and 1,567° F (TIT-197) to 1,273° F and 1,359° F respectively at 2249.

22:30-23:26 During this period, the Control Room Supervisor sought and received approval from the PSM and the System Engineer to jumper the Kurz flow meter to allow starting the 14 minute purge timer to support burner relight. This action removes the low flow alarm function and required by the Burner Management System NFPA Code to prevent accumulation of combustible gases; however, TIT-092 shows that the Afterburner temperature is greater than 1,400° F for auto ignition. The CRS knew he had an alternative of remaining bottled up and allowing the Kurz flow meter to dry out and return to normal operation, which in fact occurred later on during a later bottle up (23:20).

22:34 The Afterburner's first reading below 1,400° F caused an interlock alarm preventing relight of the burner. At this point, The CRS could have directed the DFS operator to discontinue the purge to reduce cooling and bottled up by turning off the ID fans and combustion air blowers to allow the Afterburner temperature to rise because of heat capacity in the refractory brick. See Appendix D, Figure 2 for the after burner temperature history and analysis.

22:49 CAB flow is reduced and negative pressures go to –2 " WC (-3.5") in kiln and –6 " WC in Afterburner. Duct pressure varies between (-3.5" to –3.8 WC) until 23:36, when clean liquor flow is lost and Agent is drawn into the DFS from the ECR B. The DFS Operator quickly made adjustments (over 10 minutes) to the ID inlet damper (PV-18) with the DFS pressure controller (16-PIC-18) apparently trying to make the DFS pressure less negative.

23:19 The DFS operator mistakenly secured the clean liquor recirculation pump. As clean liquor flow is lost, flue flow increases and duct pressure drops to (- 4.0" WC). Agent is drawn into the DFS from the ECR B.

23:26 First ACAMS alarm in the stack (701C) at 0.67 ASC occurred. Afterburner temperatures were at 1, 248° F and 1, 281° F. Control Room Utility Operator initiated Contingency Procedure action and orders all site personnel to don masks, notified the EOC and started site notifications. See Appendix D, figure 2 for the ACAMS history analysis and figure 3 for the kiln pressure history analysis.

23:27 Site Notifications completed and included PSM, Shift Safety Manager, CRS, Shift Environmental Representative, Monitoring Lead, and The QASAS.

23:28 Second ACAMS alarm in the stack (701A) at 1.57ASC.

23.31 Monitoring team proceeds to stack to evaluate ACAMS and pull DAAMS tubes for laboratory analysis.

23:33 The Notifications to Site Personnel and EOC were completed. Informal notifications to management were not conducted.

23:35:50 Both ID fans shutdown due to high amps. The Emergency Blower starts. The DFS operator quickly secures the Emergency Blower. Kiln pressure increases above ECR pressure. Agent vapor flow to the DFS flue is terminated.

23:36 CABS in the Afterburner to "high fire" as an auto function on loss of ID fans. CAB blowers were manually shut down By DFS operator. CAB flows go to zero. Negative pressure values of –2" (-3.5") and –6" WC return to the kiln and Afterburner. Agent vapor is again drawn into the DFS from ECR B. Afterburner temperatures were at 1,205° F and 1,238° F. Operator puts Emergency Blower in manual and stops it. See Appendix B, Figure 2 for the after burner temperature history and analysis.

23:36-39 Second stage of ID fan brought up and then shut down on high amps. First stage brought up and shut down on High Amps. Second stage brought up again.

23:38 Monitoring Team reports the Stack ACAMS evaluation results. "The agent peak is good, it covers the full width of the agent gate at one-half maximum. I recommend you put a rush on the DAAMS." The CRS interpreted "good" to mean there is not probable agent and did not initiate Contingency Procedure additional actions for "Probable Agent" including notification of the Management Advisory Team (MAT).

23:41 First alarm in DFS flue duct occurred (from DFS/PAS to common stack) ACAMS 702 at 1.45 ASC. The PSM and CRS considered the 701 ACAMS alarm on the common stack to be false because ACAMS 702 in the DFS duct should have occurred first. Later investigation and analysis determined that the 702, sample line was fouled with caustic from carryover that neutralized the agent vapors.

23:42 The Control Room Utility Operator notified the EOC of the ACAMS 702 alarm. The Control Room Supervisor directed operations to bottle up the furnace. Kiln pressure increases to –0.2" WC terminating agent flow from ECR B to the DFS. At this point the PSM and the CRS thought that the alarms were caused by "interferants" since many false ACAMS alarms had occurred in the past.

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00:17 All Stack and Duct ACAMS alarms have cleared by 00:08 and remained clear for 9 minutes.

00:18 The PSM unmasked the site.

00:23 The CRS directed the DFS Operator to attempt to come out of "bottle up", purge and relight the DFS Afterburner. The DFS operator started the first stage ID fan.

The Afterburner temperature was 1,584° F. Kiln pressure decreases to –2.7" agent vapor is again drawn into the DFS from ECR B.

00:25 The Utility Operator notified EOC that All ACAMS alarms are have cleared and DAAMS sample results are pending

00:26 The DFS operator started the Afterburner CAB. Kiln pressure increased to -1.1" WC terminating agent vapor flow into the DFS flue.

00:29 Received ACAMS alarm on common stack 701B at 0.39 ASC and duct ACAMS 702 at 0.86 ASC. Control Room utility operator ordered all site personnel to mask.

00:30 The Control Room Utility Operator notified the EOC, and completed site notifications (Safety, Environmental, Monitoring and QASAS). Received ACAMS alarm on common stack 701C at 0.56 ASC.

00:32 The DFS operator secured the ID fan and reduced CAB flow to the Afterburner. Kiln pressure increased to –0.3" WC terminating agent vapor flow into the DFS flue.

00:40 Stack ACAMS 701 B alarm cleared.

00:44 The DFS operator secured the CAB for the Afterburner and bottled up the furnace.

00:56 Duct 702 ACAMS alarm cleared. Safety, Environmental and QASAS have been notified that all ACAMS alarms have cleared.

00:57 The Control Room Utility Operator received the DAAMS laboratory confirmation concerning the first release. Contingency Procedure action was not taken to request RTAPS downwind monitoring and activate the Management Advisory Team (MAT).

01:03 The PSM reclassified event as Action Level 4. QASAS was notified.

01:07 The PSM unmasked the site.

01:08-01:15 EG&G Environmental Compliance, Safety, and Risk Managers notified.

01:17 The Utility Operator notified the EOC that the DAAMS tubes for 701A/B/C Confirmed chemical agent at 2.74 ASC.

01:31-01:38 EG&G Deputy General Manager (DGM) for Operations, and Plant Operations Manager notified

02:30	PAS 701 DAAMS tube laboratory analysis confirmed the release of chemical agent. Control Room Utility Operator notified EOC.
03:00	DSHW notified. The report was recorded on the DSHW answering machine.
04:00-04:30	The EG&G DGM of Risk Management, PMCD Assistant Project Manager for Operations, Compliance and Monitoring and DCD Civilian Executive Assistant met on site to evaluate the situation and further investigation and recovery actions.
08:00	DSHW was notified via conference call with PMCD and EG&G senior management.

2.2 Operations

2.2.1 Roles and Responsibilities

The TOCDF Organization charts were revised in April. Line management at this facility includes the General Manager, Deputy General Manager-Plant Operations, Plant Operations Manager, and Plant Shift Managers for their respective shifts.

TOCDF operations are conducted on a 24-hour per day, seven-day per week basis. Each shift is 12 hours long. Four teams (A-Team through D-Team) work the shifts on a rotating basis. Each team is led by a Plant Shift Manager (PSM). His three primary direct reports are the Operations Supervisor (OS) who is responsible for activities in the plant outside the control room, the Control Room Supervisor (CRS) who is responsible for control room activities and the maintenance supervisor who is responsible for all maintenance activities. Each supervisor is responsible for a variety of operators. An operator is stationed at each of the four furnace systems and at the utility console in the control room. Other operators man consoles that control demilitarization machines and other activities. In addition, special operations may require additional operators such as occurred on the day of the release when a DPE entry was made into ECR-B. PAS operators, entry team members, and unpack area operators, among others report to the Operations Supervisor. The instrument technicians report to the maintenance supervisor.

2.2.2 Description of Shift Operations

On the eighth of May, the regular PSM and OS were present, but the usual CRS was off that night. The qualified and certified acting CRS was normally the assistant to the CRS for A-Team. The DFS operator had been certified in February and had little experience with the DFS because it was A-Team policy that operators would rotate among the different stations. Two other members of the A-Team were also off that night; however, more than enough personnel were present to handle scheduled operations. After the watch turnover, the OS conducted a pre-operations briefing for the DPE entry. No formal record was provided, but the following shift personnel were present:

1. DSA Lead
2. DPE Entrance Controller

3. Two DPE Entrants
4. Maintenance Lead
5. Operations Supervisor
6. Shift Safety
7. Shift Quality
8. Shift Environmental Representative

Neither the PSM nor the CRS was present. At the brief, it was decided that if time allowed, routine preventive maintenance such as cleaning AQS strainers would be done after clearing the ECR-B/DFS feed chute lower tipping gate malfunction. The CRS was not aware of this intent according to his statement. The PSM directed the CRS to obtain concurrence from a Systems Engineer for using the Non-Normal procedure, DFS-011-01, DFS Feed Chute Line A Explosives Cleanout, for the DPE entry. The DFS operator had not used that procedure before and it came with a memo from the Plant Operations Manager that was written on March 20 describing a specific desired operating configuration. No instructions for recovery were provided in the Memorandum, the Non–Normal Procedure or the DFS Standard Operating Procedure.

The DPE Entry Team experienced multiple failures with cleaning equipment during the entry and spent more time dealing with the chute than planned. The DPE Entry Team did clean agent strainers as planned. The upper and lower chute gates were open while the DPE Entry Team was present in ECR-B. The DFS operator and the DPE Entry Controller communicated through headset during the entry. The CRS was not on a headset and not aware of the detailed activities conducted during the entry and that the AQS strainers had been cleaned and residue placed on the feed gate nor was he aware that the DPE entry team was inside the ECR-B when both chutes were open.

The CRS was not aware that the ACAMS for the ECR-B was calibrated in MPL and of the ECR-B general level of contamination measured in the MPL during the entry and for most of the shift. Further, he was unable to relate readings in MPL to equivalent IDLH or TWA.

Shortly after the entry was complete, the DPE Entry Controller (an experienced certified DFS operator) joined the DFS operator in restoration efforts that were not successful. Both related in the interview that they did not have authority to shutdown or "bottle-up" the furnace in an emergency and that either the CRS or PSM had to authorize that action.

As stated in the previous section, the CRS was preoccupied with administrative work related to Lockout/Tagouts and work permits. He knew there was an unstable furnace and allowed the DFS operator to continue his effort to regain control because he considered it to be good training. The PSM stated that he concurred with the CRS having the DFS operator continuing for training. The extent of the PSM's knowledge of the furnace's condition was not clear. Confronted with the Kurz failure problem, the CRS chose to jumper out the safety feature rather than determine and correct the cause. The PSM along with Safety, Quality, and Environment shift representatives concurred.

The TOCDF management system allows deviations from procedure and design basis requirements to occur at the shift level to bring the facility into a safe condition.

Operation Management Memoranda are used to provide direction to operators. However, OMM-00-05 specifically modified a procedure without the typical review process. There is no indication that this procedure as modified by the memorandum had been evaluated or tested.

In the period from January 1, 2000 to April 5, 2000, there were 80 ACAMS false positive alarms. The report from the monitor who evaluated the first 701 ACAMS alarm to the CRS was misinterpreted by the CRS who considered that the report confirmed a typical, false alarm.

There were no effective investigation actions taken that revealed the agent release path in the time after the first release and before the smaller second release. Nonetheless, the PSM directed a second re-light effort without having identified the source of the release.

2.3 Training

2.3.1 Program

The training program is comprehensive, well documented and fully implemented. The Army sponsored program provides basic training at a central training facility in Maryland. Instructors at CDTF provide formal classroom and console simulator training. Personnel are considered qualified upon completion of their required training. Qualified instructors provide local training in a formal classroom environment for both general employee and refresher subjects. No furnace simulator training is available at the TOCDF site. All personnel are required to certify in their assigned positions through a local on-job-training (OJT) checklist process. Final certification is granted following an oral examination of the candidate for critical job assignments which are Control Room Operations Supervisor, Outside Operator, Control Room Operator and Plant Shift Manager. Refresher subject training is scheduled as required.

Plant operations personnel administer a required reading program and conduct informal OJT in the plant. Biennial recertification is required with supervisors selecting a sub-set of full certification requirements for evaluation. Little to no opportunity is afforded for training in furnace upset conditions.

2.3.2 Records

Training records were complete, well ordered, and up to date. The training status for the General Manager, Deputy General Manager Plant Operations, and Plant Operations Manager were reviewed. Training records for the A-Team shift were spot-checked. Records for the Plant Shift Manager, Operations Supervisor, CON Supervisor, DFS CON Operator, and DPE Entry Controller were inspected.

Each member of the control room was qualified and certified in accordance with the requirements. The General Manager was assigned in March of 1998 and completed certification on May 23, 2000. The Deputy General Manager Plant Operations was assigned in July of 1998 and certified in February of 2000. The Plant Operations Manager was assigned in October of 1999 and has not completed certification.

Further, each member of the control room team was current in required reading. The Operations Supervisor had not read SOP-004 Revision 4 Change 0 or SOP-004 Revision 4 Change 1.

The recently certified DFS Operator received 42 hours of classroom instruction on the DFS and a total of 32 hours of simulation training of which 16 hours were simulation training in eleven upset conditions.

2.4 Procedures

TOCDF maintains an extensive set of procedures including:

- SOPs (Standard Operating Procedures)
- MOPs (Maintenance Operating Procedures)
- LOPs (Laboratory Operating Procedures)
- PRPs (Project Regulatory Procedures)
- NNPs(Non-Normal Procedures)

Specifically, several of the procedures had a direct relationship to the accident of May 8, 2000. In particular, the following procedures were reviewed as part of the accident investigation:

- SOP-003, DFS PAS Operations, Rev.9
- SOP-004, DFS Operations, Rev.4, Change 1
- SOP-112, ECR Housekeeping and Maintenance, Rev.3, Chg.1
- MOP-614, DFS Blind Flange Installation/Removal, Rev.2
- PRP-OP-009, Configuration Management: Temporary Change Control Process for the Technical Baseline, Rev.10
- PRP-MG-010, Non-Normal Procedure Development, Revision and Deletion, Rev.0
- PRP-MG-013, Notification Procedure, Rev.0
- PRP-MG-014, Event Investigation and Corrective Action, Rev.0
- PRP-SA-002, Accident, Incident and Near-Miss Investigation and Reporting, Rev.2
- DFS-008-01, Plan for Non-Normal Operating Condition, Titled: DFS Feed Chute Cleanout
- DFS-010, Non-Normal Procedure for Clearing DFS Feed Chute Using Water/Air Lance
- DFS-011, Plan for Nor-Normal Operating Conditions
- DFS-011-01, Plan for Non-Normal Operating Conditions, Titled: DFS Feed Chute Line A Explosives Cleanout
- GPL-EP-001, Emergency Guideline for Control Room Operation, Rev.3
- GPL-EP-002, On-Scene Incident Commander, Rev.0
- EG-069, Integrated Notification, Investigation and Reporting Plan, Rev.0
- EG-040.A01, Contingency Procedure for Agent Detected in the Stack, Rev.2
- EG-044, Training Qualification and Certification Procedure, Rev.4
- CDRL SY-015, TOCDF Contingency Procedures
- CDRL SY-022, Limiting Conditions of Operations, Rev.2
- CDRL A012A, TOCDF Emergency Response Plan, Rev.2
- CDRL 22, Participant Quality Assurance Program Plan
- LOP-522, Depot Area Air Monitoring System, Rev.5

- LOP-524, ACAMS Operation, Rev.5
- LOP-525, ACAMS Alarm Response, Rev.4
- LOP-562, Analysis of Depot Area Air Monitoring System (DAAMS) Tubes, Rev.3
- LOP-567, GC-MSD/FPD Operation, Rev.1
- LOP-592, QC Procedures for Monitoring Operations, Rev.2
- LOP-594, QC Procedures for Analytical Operations

2.4.1 Facts Concerning the Procedures

SOP-003 describes DFS PAS Operations. It is a compilation of 10 procedures including, pre-operational conditions, system startup, manual operations, local mode operations, normal operation, system shutdown, extended shutdown, manual switchover of demisters, quench tower clean out, and pumping PAS sump-110. The use of the spare demister, PAS-DMIS-105, which was in use during the May 8 accident, is covered in this procedure. This procedure contains the following caution: "The existence of any liquid level in the Quench Tower is cause for concern and requires immediate attention by the PAS Operator." In addition, the following caution is in this procedure: "Manual control may be used to execute startup/shutdown of individual equipment during maintenance, or to recover from an upset condition that cannot be accomplished in Auto Mode." All such manual operation must be reported to the Control Room Supervisor. Operators are instructed to refer to the "appropriate contingency procedure" if a release of hazardous material occurs through the stack. This procedure does not provide guidance to operators for correcting fault conditions.

SOP-004 covers DFS Operations. In reality SOP-004 is a compilation of 11 procedures. This procedure includes pre-operational conditions, system startup, manual operations, local operations, system shutdown, emergency shutdown, extended shutdown, Afterburner flange isolation, suspected detonation and limited special operations. The section on emergency shutdown does not convey the conditions under which emergency shutdown is required or even recommended. The section on Afterburner flange isolation suggests operation by Reverse Flow Cooldown for extended shutdown. The special operations include only single and two-stage ID fan failure or loss of power even though operator training includes additional upset conditions. Credible upset conditions included in formal DFS Operator training are: Automatic Waste Feed Cutoff; Kiln Burner Lockout; One Afterburner Lockout; Both Afterburners Lockout; Furnace Shutdown; and Kiln Detonation. Special operations have not been extended to other abnormal or upset conditions, e.g. recovery from a non-normal operation such as cleaning the DFS Feed Chute. Direction regarding abnormal or upset conditions is simply to notify the Control Room Supervisor.

SOP-112, ECP Housekeeping and Maintenance, directs the Control Room Operator to notify the Lead and Operations Supervisor/Control Room Supervisor in the event of an abnormal or upset condition. Entrants to the ECR must be dressed in accordance with the guidance in TE-SOP-113. Opening ECR-B doors will affect the pressures in the upper munition corridor, the Explosive Containment Vestibule (ECV) and ECR-A. During rocket operations, the ECR is a Category A area requiring DPE for entry. When any doors to ECR are open, the associated HVAC inlet isolation dampers for that ECR must be closed to prevent agent migration into the ECV. Operators are instructed to use Appendix A for housekeeping and maintenance during rocket processing. Clear instructions regarding energetic contaminated sump strainers include placing the strainer into the PM waste container on the floor next to the DFS Feed Chute. Then all waste debris is supposed to be placed on the DFS Feed Gate. (Normally the Feed Gate is cycled to dispose of the debris.) According to interviews with personnel on duty the evening of May 8, this procedure was followed, resulting in debris with high agent content being placed on the DFS Feed Gate.

CDRL A012A describes the TOCDF Emergency Response Plan. This is a high level plan providing the entire program for preparing for, responding to, and mitigating the consequences of an emergency. The Contingency Plan satisfies RCRA Permit #UT5210090002 requirements. This Contingency Plan is actually a separate volume in a separate binder. (The Contingency Plan can be found as Attachment 9 to the RCRA Permit.) The Contingency Plan specifies the use of GDL-EP-001. Appendix B is the CAIRA, which meets the requirements of DA-PAM 50-6 and AR 50-6 for GOCO operations at TOCDF. It is based on the maximum credible event (MCE).

Contingency Procedures for several scenarios are bound in one volume numbered EG-040, where EG-040.A01 is for agent detected in the stack, EG-040.A02 is for agent detected in a limited access area, EG-040.G01 is for an industrial accident, EG-040.G02 is for fires, EG-040.G03 is for hazardous material, etc. The procedure in this series most pertinent to the accident of May 8 is EG-040.A01. An alarm of the ACAMS involving PAS 701A, B, or C triggers the use of this contingency procedure. Among other actions, an informal notification according to the procedure GDL-EP-001 is to be made. Also an event report is to be started. If there is probable agent release, several escalating actions are called for. If the ACAMS alarm is confirmed by the DAAMS, then even greater action is required, including activation of the Management Advisory Team (MAT). The MAT would report to the EOC. Closure of this procedure includes participation in review and recovery investigation and returning the plant to normal operating condition. In this event, informal notifications were not made. The MAT was not notified when required, the MAT was not activated, and the RTAPs downwind monitoring was not requested.

EG-069 is the integrated notification, investigation and reporting plan. It provides the event identification and classification criteria. The action levels range from Level 1 to Level 4. Since the May 8 accident involved an agent spill or release, the pertinent action level as defined by EG-069 is Level 4, although this was not immediately recognized by the A Shift personnel on duty that night as determined through interviews with the A Shift personnel. The specific criteria is "any release outside of engineering controls". For any classified event, a Notification Form (found in Appendix B) must be completed and distributed based on the defined action level. The Notification Form provides a description of the event, captures key data for analysis, and describes immediate actions that have been taken. A Notification Form was completed for the May 8 accident.

MOP-614 covers blind flange installation and removal. Instructions include compliance with the section of SOP-004 on Afterburner Flange Isolation Operation. ID fans and DFS Pressure Control Damper (PIC-018) must be placed in the manual position for this operation. Notes in this procedure allow for deviation from verbatim compliance with this procedure if abnormal or upset conditions exist.

Non-Normal Procedures are driven by PRP-MG-010, Non-Normal Procedure Development, Revision and Deletion. The purpose of a Non-Normal Procedure is to document procedural steps, safety, environmental and special equipment requirements for operations and jobs that are performed on a one time or infrequent basis. These procedures expire after 30 days unless extended. They can only be extended twice, then must be re-written. Chute clean out procedures for the DFS have been written at ten times and extended as required since the plant began service. Ten Non-Normal Procedures exist with similar titles and content regarding DFS chute access for cleaning or clearing jams. Two of these are active, DFS Feed Chute Cleanout DFS-008 and DFS Feed Chute Line A Explosive DFS-011-01. These active procedures require adherence to a Memorandum (OMM-00-05), which was not appended to the procedure and had to be located separately (not in procedure binder). The details of OMM-00-05 are actually in an attachment to the memo itself. Even though it was written specifically for clearing explosive jams in chute the feed from ECR A DFS-011-01 was used to clear material to correct a lower "tipper" gate malfunction from the feed chute from ECR B. The Non-Normal procedure call for entrants to exit ECR prior to opening the tipping gate (DFS-GATE-101) on the DFS Feed Chute; however, the entrants on the evening of May 8 stayed in the ECR while both gates were open simultaneously.

Procedure PRP-OP-009 defines the method to identify, approve, record, install, validate, and remove a temporary change to the plant equipment and control systems. The Plant Shift Manager has the authority to implement a temporary change; however, concurrence of other personnel may be required depending on the nature of the change. For a change that involves a RCRA item, the Environmental Shift Representative would consult with the Environmental Compliance and Permitting Managers for a resolution. The procedure calls for closure of a temporary change to ensure that the configuration has been returned to the normal previous condition. It would apply to such actions as temporary jumpering out of the Kurz meter to enable Afterburner relight after a low-low level alarm such as occurred during the May 8 accident. The function of the Kurz flow meter is to provide flow measurement and a flow present logic input to the Burner Management System (BMS). In this case, although there was flow indicated by other instruments the Afterburner temperature was below 1,400° F and bypassing the Kurz flow input to restart the burners would have not met NFPA code. A jumper to bypass the Kurz instrument is a bypass of a primary protective feature in the DFS Operating Software against flammable gas build up in the combustion chambers of both the kiln and the Afterburner.

2.5 Engineering

2.5.1 Deactivation Furnace System Design Requirements

There are three performance design requirements for the deactivation furnace system. They are:

- Thermally destroy agent vapors,
- Thermally decontaminate munitions parts/residue,
- Thermally destroy explosive/energetic material.

The design requirements must be met in a manner that is safe to plant personnel, to the public, and to the environment.

The DFS design meets the requirements through three general mechanisms:

- Explosive and energetic materials are burned in the rotary kiln through a counter current flow combustion process,
- Munitions parts and residues are thermally decontaminated to the 5X level (1000 degrees Fahrenheit for 15 minutes) in the heated discharge conveyor,
- Agent vapors are thermally destroyed in the Afterburner: temperature greater than 2050 degrees Fahrenheit and residence time greater than 2 seconds.

The DFS furnace system has demonstrated it meets the design requirements when operated at the temperatures, pressures, and flows indicated in SOP-004. The performance data comes from trial burns and performance in destroying M-55 rockets and M-56 warheads.

2.5.2 Wet Pollution Abatement System Design Requirements

There are three general design requirements for the DFS Pollution Abatement System (DFS PAS). The PAS cools DFS exhaust gases, chemically treats acid gases to environmentally acceptable levels before they are released to the atmosphere, and provides induced draft to the entire DFS and PAS system.

The PAS accomplishes these design requirements by the use of:

- Quench tower
- Venturi scrubber plunger
- Packed bed scrubber tower
- Demister
- Induced Draft (ID) Fan
- Emergency exhaust blower
- Various recirculation and transfer pumps
- Associated piping and instrumentation

The PAS processes the exhaust gases that flow directly from the furnace. The gases, cooled and scrubbed by the PAS, are discharged into a stack that is common to all four wet PASs. The spent brine produced by the PAS is pumped to the brine storage tanks (BRA Tanks) for temporary storage and then shipped to a licensed and permitted hazardous waste disposal facilities. The PAS requires process water, and 18% wt. sodium hydroxide.

The DFS pollution abatement system has demonstrated it meets the design requirements when operated at the temperatures, pressures, and flows indicated in SOP-004. This is demonstrated by performance data from previously conducted trial burns and the successful processing of M-55 rockets and M-56 warheads up to the date of this incident.

The MORT chart directed the investigators' attention to areas such as Human Factors. In that regard, the CROs have to view multiple computer screens to status the DFS Furnace and PAS operating systems through a complex man/machine interface. There are 12 primary screens associated with the DFS Furnace and PAS operation. In addition there are a large number of auxiliary screens with supporting information.

2.6 Maintenance

Maintenance records were reviewed for the evening of May 8. No maintenance activity was scheduled for the DFS. The emergent maintenance discussed in the pre-entry brief for the chute B clean out evolution included cleaning agent strainers and routine ECR B preventive maintenance. Entry time limits precluded the preventive maintenance; however, the agent strainer was cleaned and placed on the B chute slide upper gate per procedure.

2.7 Environment

The agent stack release on May 8, 2000, was reported to all appropriate regulatory agencies within the time frame required by TOCDF's RCRA permit. The stack release at 23:26 on May 8th was a potential noncompliance with TOCDF's RCRA permit as it exceeded the maximum allowable stack concentration for GB agent of 0.0003 mg/m3 (1 ASC). There were no other potential environmental noncompliance's associated with the event that took place on May 8th and 9th. The agent release from the common stack at 00:28 on May 9 was below the permit limit.

2.8 Quality

An examination of quality assurance records was conducted that shows a recent trend toward more frequent events at TOCDF. Until recently the site had experienced no more than 13 events in any given month according to the Quality Assurance records. There have been 22 events in March, 25 events in April and 10 events in the first 10 days of May with the plant's first confirmed agent release.

Multiple deficiency management and tracking systems are in use at TOCDF. QA, Environment, and Safety use the Deficiency Report; engineering uses the ECP; and Operations has another system. In addition, another system tracks investigation corrective actions. Several outstanding corrective action items have been closed by opening another action item, sometimes in a different system. In particular, Engineering Change Proposals (ECPs) have been used to close event-related corrective actions. The ECPs in and of themselves do not accomplish the corrective action; they only start the process.

Several previous events have required an excessive amount of time to close; sometimes taking a year or more. A few events do not have a record of closure in the QA system. Closure reports are not in the QA records.

2.9 Safety

An engineering analysis to determine the amount of agent released was performed using ACAMS readings (ACAMS 701A & 701C) during the period of 23:26 to 23:52, May 8, 2000. From this calculation it was determined that approximately 17 mg of agent was released in this 25-minute event. The second release alarming at 00:28 on 9 May and lasting 28 minutes released approximately 1 mg of agent.

Raw data was used by the United States Department of Health & Human Services (DHHS), Centers for Disease Control and Prevention (CDC) to assess the public health risks to both workers and the community. The data was used to run a "worst-case EPA-approved air dispersion Model". The results showed the release posed no short or long-term threat to the health of the general public.

This same analysis determined that the maximum possible exposure to agent GB at ground level during this incident was less than one percent of the Department of Health & Human Services (DHHS) acceptable safe level for such an exposure to the general public.

The air dispersion model that was used was based on a "worst-case parameters" methodology, including meteorological down-wash to determine maximum local agent concentrations. This analysis demonstrated that down-wash conditions would not have occurred for any significant duration. The maximum possible exposure amount for workers was less than one-percent of the safe exposure amount. In addition per the related Contingency Procedure, the entire site was ordered masked by the utility control room operator upon receipt of the first ACAMS alarm making actual exposure (from inhalation) even less likely.

There were no other indications inside the facility nor around the perimeter, confirming the release was a localized and confined to the common stack. Because of all these factors there was minimal to no health or environmental risks from this incident.

2.10 Security/Surety

Security was considered for completeness. There were no security-related concerns developed in the investigation.

Surety was also considered for completeness. Agent quantities in this event were below surety level quantities. There were no surety related concerns developed in the investigation.

3.0 CONCLUSIONS

3.1 The following conclusions can be drawn from the data available;

3.1.1 The DFS was out of service because the tipping gate malfunctioned from material buildup on the gate necessitating a DPE entry to clean out the chute.

3.1.2 The overall operation of the facility should be directed by the Plant Operations Manager. Operations management should ensure that only trained and qualified personnel operate plant equipment in accordance with approved procedures. Non-routine operation of controls should not be made without specific approval of the Control Room Supervisor except that during emergencies, operators may take necessary immediate actions required to ensure personnel, plant, and environmental safety without obtaining prior approval. However, appropriate supervisors should be promptly informed of these actions. Operators should be instructed that plant safety should be achieved over facility production for off normal and emergency facility conditions.

3.1.3 In the absence of a standard or non-normal procedure for ECR B, a non-normal feed chute clearance procedure for ECR A was given by the PSM to the CRS to guide control room operators and other shift personnel in the entry and clean out work. That procedure contained errors in component nomenclature and included a reference to an Operational Management Memorandum Program (OMM) Memorandum that included configuration and operating parameter guidance that had not been evaluated or tested operationally. Furthermore, the operator guidelines were an attachment to the memorandum. Both the memorandum and its attachment could be separated from each other and the non-normal procedure. A non-normal procedure for ECR B should have been prepared and approved or the ERC B procedure formally modified and approved using the related plant process. The guidance in the memorandum should have been included in its entirety in the non-normal procedure and shift personnel trained in it. Because of the frequency of ERC entries, and SOP should be prepared.

3.1.4 The non-normal procedure causes the DFS to operate outside its normal operating parameters with twice the usual flow to develop a kiln pressure that is lower than the ECR pressure.

3.1.5 Low kiln pressure relative to the ECR introduced agent vapor from the agent contaminated ECR and the agent strainer basket on the slide gate into the DFS.

3.1.6 It is unknown if the automatic control system could have established normal operating conditions because the operator exercised manual control of the system; however, slow control loop tuning would have caused a significant delay in system response. The PSM or the CRS should approve all process rate changes because these persons are held accountable for safe operation. Additionally, they will probably be the persons most knowledgeable of problems that occur as a result of changes. Nevertheless, the operator should be authorized to decrease rate without approval, if necessary, to respond to a facility emergency situation in accordance with the facility's emergency procedures.

3.1.7 Manual control inputs to PIC-18 to control kiln vacuum were ineffective in reducing the higher than normal flow through the system. This contributed to high moisture carry over (entrainment) and both high moisture on the Kurz probe and difficulty with clean liquor level in the scrubber.

3.1.8 The scrubber clean liquor system is unable to maintain adequate levels under high flow conditions. High flue gas flow rates were "scavenging" clean liquor from the scrubber removing the liquor from the system. Also, it was reported that the system has difficulty maintaining adequate levels under normal conditions.

3.1.9 Utilization of the Process Water (PW) sprays for make up to the clean liquor under high flue gas flow conditions provided additional moisture that contributed to high moisture into and failure of the Kurz meter probe, clean liquor deposition into the 702 ACAMS sensor, and increased the load on the ID fans. The PW spray in the scrubber tower is intended to spray the mist eliminator pad and, as currently designed, increases the potential to cause moisture entrainment; therefore, the clean liquor recirculation capacity and its make up feed from process water should be modified to maintain normal sump level across the full range of flue gas flow.

3.1.10 Failure of the Kurz meter caused automatic shut down of all three burners in the DFS (One in the Kiln and 2 in the Afterburner). The need is evident for either replacing the Kurz meter and system with one that is not moisture sensitive to improve reliability or develop redundant means of measuring flow associated with a comparison, vetting or auctioneering networks and software to ensure one incorrect alarm does not lock out the burners while operators are ensuring flows by observing other indications.

3.1.11 The only existing design control that will contain agent vapors in the DFS kiln is applied by installing the blind flange and potentially exposing workers and the environment to agent vapors if the pressure in the DFS flue is above atmospheric pressure. EG&G Defense Materials had recommended installation of an isolation valve that could be remotely operated from the control room. This isolation value would contain agent vapors in the DFS kiln should flue gas flow be high, kiln and Afterburner temperatures be too low, and residence time be too short to ensure incineration.

3.1.12 Agent vapor in the DFS was not thermally destroyed because of the low DFS temperature (approximately 1,160° F) and low residence time (under 2 seconds).

3.1.13 The DFS/PAS Induced Draft (ID) exhaust fan system develops much more flow than is necessary to ensure proper operation and can exacerbate operator errors.

3.1.14 Percolating flue gas through clean liquor in the scrubber did cause a dampening effect on the flue gas flow and allowed some agent absorption at the low level concentration that was present during this agent release.

3.1.15 If the LOPs regarding ACAMS and DAAMS had been followed explicitly, the minor errors, some of which contributed to the misidentification of the source of DAAMS data coming from station 704 vice 702, that were made during the May 8-9 accident could have been averted. However, the minor errors did not exacerbate the severity of the accident nor hinder its amelioration.

3.1.16 In the TOCDF procedure system there is no clearly defined hierarchy, the workforce does not understand the hierarchy of documents, and in many cases multiple documents address single topics or functional areas, such as emergency response. The result is it is not clear what specific document(s) should be used in any given situation especially in highly dynamic, non-normal operating conditions.

3.1.17 TOCDF has been operating since 1996 and the operations are based on years of prior Chemical Demilitarization experience involving the incineration of chemical agents using similar systems. The operations have transitioned to production. Consequently, it is difficult to understand why the site operating procedures are prefaced by a note that states: "During abnormal or upset conditions the Plant Shift Manager or designee may deviate from this SOP in order to bring the plant back into a safe and environmentally sound condition and configuration." The caveat or disclaimer in the SOPs which allow the Plant Shift Manager without communications with upper management to deviate from procedures to restore the plant from upset to safe and normal conditions may be abused and is not the proper method to resolve situations caused by inadequate SOPS, contingency procedures and non-normal procedures in handling probable plant and equipment problems. Certainly, an emergency or contingency action procedure must be available for abnormal or upset conditions and it would be appropriate to identify that procedure and require that it be followed meticulously. Then the note in the forward of SOPs would simply reference the emergency/contingency procedure. The current caveat regarding abnormal conditions encourages a mindset of expert-based operations instead of standards-based operations. Realizing the time required for development and training "standards based" rather than "experienced based" operations should be the desired goal for TOCDF.

3.1.18 The temporary change policy in the procedure PRP OP-009 requires revision since it permits the Plant Shift Manager (PSM) to implement temporary changes such as that involved with jumpering the Kurz meter. This action would not have met the NFPA Code since the Afterburner temperature was less than 1,400° F and removed a protective feature in the Burner Management System. Although the temporary change was prepared, the Kurz meterjumper was not installed. This should not be done unless there is a complete understanding and acceptance of the risk involved and special mitigating measures identified. Higher authority than on shift personnel should be required to approve code work arounds and interpretation and safety feature removal. Further, it allows the PSM to authorize modifications with only review from on-shift safety, environment, and quality assurance personnel and phone confirmation from a system engineer. Prior to modification, this control should provide for communicating the installation of temporary modifications to the design authority to allow for technical oversight and an evaluation of the impact on current design activities, and approval of the design modification. These control systems should make provisions for safety reviews, installation approval, independent verification of correct installation and removal, documentation of the modification, update of operating procedures and documents, training, marking of installed modifications, and periodic audits of outstanding modifications.

3.1.19 The authority given the PSM to deviate from SOPs, make temporary changes to safety, code, permit and protective features without reference to senior line management gives shift managers and supervisors a high degree of autonomy and potentially separates senior line management from understanding the condition of the plant, obtaining informal reports during contingency plan execution and delays timely reports of upsets and emergencies, and keeps senior management from providing advice and assistance.

3.1.20 Document control requires much improvement. At least three versions of the same document (Contingency Procedures) were found in the Control Room. The operators all believed that they had the current version and were acting based on that supposition. Since TOCDF uses a hard copy document control system, it is incumbent upon the individual document holders/users to ensure that they have current revisions and replace out-dated documents in their binders. Further, it is incumbent on management to have an oversight system to ensure proper document control and that only the most current revisions are being used by operators. The failure rate for this type of document control system depends on human reliability and is normally considered to be a few percent. For critical documents, this is probably too great a residual risk. Electronic on-line document control systems have lower failure rates and more positive control of documents where broad distributions mean many manual holders are involved.

3.1.21 The need for improved adherence to procedures was noted in using a non-normal procedure for the wrong ECR, the entry personnel remaining in the ERC-B while upper and lower feed chute gates were open simultaneously and being cycled, some missing notifications, and a missed request for RTAPS downwind monitoring, required by the Contingency Procedure, and three missed steps in the sampling and analyses LOPs.

3.1.22 There is a prevailing consideration among some operators and managers that agent will be destroyed as long as temperatures are above 1,000° F. As this event proves, this consideration is not true of this plant since at temperatures between 1,160° F and 1,250° F, twice the normal flow and a residence time less than 2 seconds, agent destruction did not occur. The operators need a guide that correlates Afterburner temperatures and flow/residence time, and the plant needs an engineering control feature to isolate the agent should residence time be too short for total incinerator.

3.1.23 Operators and supervisors were hesitant to believe the ACAMS alarm because of the myriad of false alarms documented for the current alarm system. This led to a hesitation in bottling up and search for a source of the agent. And ultimately to the second release in the event. Operators and supervisors should believe instrument readings and treat them as accurate unless proven otherwise. Ignoring an unusual reading because the operator believes an instrument is faulty can cause abnormal conditions to be undetected. In general, operators should check other indications, if possible, when unexpected readings are observed. Prompt action should be taken to investigate the cause of abnormal or unexpected indications so that prompt corrective action can occur. When malfunctioning or inaccurate instruments are discovered, they should be appropriately identified to prevent subsequent confusion and instrument and control personnel should be in place to effect repairs. In situations of operator doubt, operators should be instructed to achieve personnel, facility, and environmental safety above facility production.

3.1.24 Some operators did not have a feel for the levels of agent contamination in the ECR and were not aware of the path for agent flow set up by plant conditions during the recovery. Training upon the information developed during this investigation should be in lessons learned and other training, especially on shift training.

3.1.25 Because of the twelve primary computer screen displays associated with DFS furnace and PAS operation and the large number of auxiliary screens providing information, it is difficult for the CRO, the CRS and the PSM to obtain essential plant operating conditions in a reasonable time particularly during upset conditions and the associated recovery processes. A DFS/PAS schematic or a single computer screen showing essential components, control device positions, current alarms and current operating temperatures, pressures, flows, etc. is required.

3.1.26 The formal training program appears strong and meets program requirements; classroom training records, qualifications and certifications are well documented; and operators have had required training at the Aberdeen simulator. Nevertheless, CROs, the CRS and PSM did not demonstrate a firm grasp of plant dynamics, component purposes, operation and interrelationships. Accordingly, the substance and retention of the training material is of concern and should be addressed in the training program particularly in on shift training. Furthermore, the need for an on site simulator upon which to train on upset conditions and the recovery from them is obvious.

3.1.27 There is a recent trend toward more frequent events. There are multiple systems for tracking issues/corrective actions. The practice of shifting issues between the Deficiency Report (DR) system and other tracking systems should be avoided because it leads to excessive time to close issues, complete loss of tracking to closure of some, or loss of data for audit and trend analysis. Further, corrective actions take a long time to close, some are closed by ECP initiation rather than correction and some events do not have closure reports in the QA and safety records. A simpler and more rigorously enforced system is needed and QA and safety personnel should be closely connected to the process. Inspections, audits, reviews, investigations, and self-assessments are a part of the checks and balances needed in an operating program. Line managers and supervisors should perform routine observations of personnel performing operating activities. Also, other groups, such as quality assurance and safety personnel, should periodically review and assess operational performance. These reviews can assist line managers and supervisors in identifying and correcting problems. Deficiencies identified in all audits, investigations, and reviews should be documented, tracked, and corrected all under one system.

3.1.28 It is not clear from the available documentation how and where issues from previous incident investigations have been tracked to closure. In addition, there is no documented evidence that lessons learned from either the Chemical Demilitarization Operations Manual (CDOM) or the Program Lessons Learned (PLL) have been implemented at TOCDF. Both programs have issues/items that have a direct bearing on this incident.

3.1.29 The ACAMS alarm from station 702 did not precede the alarm from station 701 apparently because of contamination due to caustic in the high moisture carry over.

3.1.30 The operations in progress during this shift were about one third of potential operations that the control room is designed to handle and less than conducted on the average.

3.1.31 After the Kurz failure and burners were secured, there was no effective effort made to determine why the Kurz meter malfunctioned nor action taken to correct the problem before attempting to restart the plant. This behavior was repeated before the second stack release. Facility trips and unplanned forced shutdown require a thorough investigation. When protective devices trip (e.g., circuit breakers, fuses, multi-channel logic permissives), an attempt should be made to understand the cause of the trip before the device is reset. Normally, before action is taken, an operator should ensure no abnormal condition exists that would preclude reset, because the consequences of inappropriately resetting protective devices vary considerably, good judgment and specific guidance are necessary in this area. The operations management should provide the appropriate guidance so that tripped protective devices will be properly addressed.

3.1.32 The Operational Management Memorandum (OMM) program is and should be used to convey information such as special operations, administrative directions, special data-collection requirements, plotting process parameters, and other similar short-term matters to operators. Examples of such memoranda could include amplifying information on the need for and performance of specific evolutions or tests; it could also include work priorities, announcements of policy information, and administrative information. These memoranda should be clearly written, dated, and maintained in the control room. Information, policies and operating guidelines intended as permanent should be incorporated into appropriate procedures. The OMM program should not be used to change operating procedures, because the changes noted in the operator orders might be missed by a procedure user. Additionally, OMM program memoranda may not receive the reviews or approvals appropriate for a procedural change. Therefore, information intended to supplement operating procedures should be promptly incorporated into the appropriate procedure by a procedure change or revision.

3.1.33 Several instances of poor communication between shift personnel during this event have been identified. Since accurate communications are essential for the safe and efficient operation of facilities, guidance in the use of various forms of audible communication is necessary. This includes repeating back instructions to ensure the accurate transmission and receipt of verbal instructions. Standardized terminology and the use of a phonetic alphabet are other means of ensuring verbal communications are understood.

3.2 Analysis of Event Causes

3.2.1 Root Causes

These root causes set up the path and driving force for agent release to the DRS furnace, PAS and Common Stack. There are two separate but related root causes for this event: performance of the Non-Normal Procedure (NNP); and a DFS Operator unprepared to recover from the upset condition generated by the Non-normal procedure.

3.2.1.1 Performance of the non-normal procedure as modified by memorandum required the DFS and DFS/PAS to be operated in a upset condition, i.e. kiln pressure lower than the ECR pressure that, in turn, required higher than normal flow rates through the entire system. This was done for safety of personnel reasons to prevent flow from the kiln to the ECR up the feed chute and protect the DPE entrants in the ECR from hot kiln gases and prevent a fire or explosion while they cleaned out the ECR B feed chute; but, at the same time, set up a condition for agent flow from the ECR to the furnace and PAS.

3.2.1.2 The recovery from the DPE entry into ECR B to normal operating conditions was not successfully accomplished. Recovery from the non-normal condition after completion of activities in the ECR required returning the kiln to a stable pressure slightly higher than the ECR room pressure and lower flows to ensure longer and proper residence times and proper system component operation. To accomplish this required a level of knowledge and an understanding of the DFS and DFS/PAS system and manual control input cause and effect relationships that the inexperienced, certified DFS Operator, and the certified DFS Operator assisting him did not have.

3.2.2 Direct Causes

These causes prevented the operational engineering features from destroying or absorbing the agent in the furnace and PAS systems:

3.2.2.1 The lack of control of the DFS recovery operation resulted in the loss of burners in the kiln and after burner, and allowed them to cool below a temperature that would destroy chemical munitions agent at the short residence time (below the low alarm point) caused by the excessive flow in the DFS furnace and PAS systems.

3.2.2.2 Operator action to secure clean liquor flow to the scrubber eliminated the last physical barriers to agent release by removing the damping action of the clear liquid circulation in the scrubber on flue gas flow and the coincidental ability of the clean liquor to absorb low levels of chemical agent. The scrubber is not a design engineering control to prevent the release of agent vapors to atmosphere but was installed to remove acid gases from the flue gases.

3.2.3 Significant Contributing Causes

The following are significant contributing causes to the release of agent vapors to the atmosphere through the introduction of agent vapors into a DFS and DFS PAS that did not have adequate temperature and sufficient residence time to allow the vapors to be destroyed by incinerator.

3.2.3.1 Delays in actions to contain agent vapors (system bottle up) were caused by the following factors and led to the second release from the stack:

3.2.3.1.1 The PSM, the DFS Operator and Control Room Supervisor did not believe the first 701 ACAMS alarm because of the history of frequent false alarms and because the 702 ACAMS did not alarm first. Therefore, they did not take prompt actions to bottle up the system.

3.2.3.1.2 In determining a probable agent release, the PMS and CRS, were waiting for the 702 ACAMS DFS duct alarm which was sensed upstream the common stack alarm and the DAAMS sample laboratory confirmation. The CRS failed to understand the monitoring team's 701 ACAMS printout report, " I have a good agent peak. It covers the full width of the agent gate at one-half maximum. I recommend that you rush the DAAMS result." The CRS stated that he thought that good meant no agent. His evaluation and discussion of it with the PSM precluded bottling up even though bottling up would have recovered Afterburner temperature and stopped agent flow up the stack.

3.2.3.1.3 The CRS and DFS operator's preoccupation with continuing attempts to relight the burners including jumpering the Kurz flow measurement to clear the low flow alarm also delayed the decision to bottle up.

3.2.3.1.4 Failure to believe the indications which supported agent release, determine the condition allowing the agent release and bottling up contributed directly to the second release of agent out the common stack.

3.2.3.2 Higher than normal flow through the whole DFS & DFS/PAS system caused the following non normal conditions:

3.2.3.2.1 Shorter residence times in both the kiln & Afterburner.

3.2.3.2.2 Higher than normal moisture carryover (entrained moisture) from the kiln to the Afterburner, and on through the pollution abatement system.

3.2.3.2.3 The high flow caused a "scavenging" effect on the scrubber clean liquor sump resulting in difficulty maintaining scrubber clean liquor sump level. Accordingly, the DFS operator was required to manually add make up process water to control "level". The configuration of the clean liquor make up feed spray heads increased the amount of moisture being fed into the mist eliminator pad portion of the scrubber tower and increased moisture entrainment.

3.2.3.2.4 High flow rate combined with the manual operation to add water and maintain clean liquor level caused entrained moisture to be drawn across the Kurz flow meter causing it to fail in the low flow alarm condition. This alarm caused the BMS to shut down all three DFS burners (one in the kiln and two in the Afterburner).

3.2.3.3 Factors that contributed to cooling of the Afterburner during this incident are the following sequence of events:

3.2.3.3.1 DFS operator reduced the pressure of the kiln so that the kiln pressure was lower than the ECR room pressure during execution of the Non Normal Procedure to clean out the ECR B feed chute. The control mechanism to reduce pressure in the kiln is to increase induced draft by opening the Induced Draft (ID) fan damper causing increased flue gas flow through the DFS and the DFS PAS. This increased flow contributed to lowering the temperature in both the kiln and the Afterburner.

3.2.3.3.2 Failure of the Kurz flow meter also caused automatic shutdown of the burners in the after burner. When the burners shut down the Burner Management System (BMS) automatically ran the combustion air blowers to "High Fire", increasing the flow through the Afterburner with the burners off, further reducing the temperature. Burner shutdown combined with the already established higher than normal flow rate, and CABs at high fire, caused accelerated temperature drop in the Afterburner.

3.2.3.4 The need for improved Procedures contributed to the cause:

3.2.3.4.1 The non-normal procedure selected by the PSM, its referenced memorandum and the DFS Operations procedure did not provide necessary guidance in recovering the DFS Plant from the upset condition used to support ECR B entry.

3.2.3.4.2 The DFS operating procedure does not contain directions for bottling up the furnace or restarting from a bottled up condition.

3.2.3.5 The Training program as executed did not ensure that the shift operators' and supervisors' learned and retained: the fundamental knowledge and understanding of plant components; their functions and controls; the interrelationships of the components and controls in the dynamics of plant recovery; and the effects of control actions on plant measured parameters.

3.2.3.6 The need for improved communications affected the control of the plant, delayed the understanding that agent vapors were being emitted from the stack and bottling up the plant, hampered the PSM and CRS in understanding the plant status, and delayed the notification of key plant managers who could have assisted.

4.0 RECOMMENDATIONS

The top eleven recommendations are in the following order: 4.1.1; 4.1.2; 4.2.1; 4.2.2; 4.3.1; 4.3.2; 4.2.3; 4.3.3; 4.3.4; 4.3.5; and 4.4.1.

4.1 Procedures

4.1.1 Prepare a comprehensive and detailed Standard Operating Procedure for ECR Feed Chute Cleanout and gate malfunction and jam correction. The procedure should include: the philosophy, guidance and direction included in memorandum number OMM-00-05; the procedures for establishment of ECR, DFS and PAS Systems conditions for support of the evolution; and, the procedures for restoration of the ECR, DFS and PAS systems to normal operating conditions. References to necessary supporting Standing Operations Procedures (SOPs) such as SOP 112, ECR Housekeeping and Maintenance, should be made in the procedure. (See Appendix "C" Operations Procedures for guidance).

4.1.2 Establish a discipline through training and management oversight, involvement and monitoring of operations in the control room and other appropriate portions of the plant to ensure that the correct and current procedures are habitually opened and used for current normal and non normal operations and evolutions, that all required actions are taken in the sequence prescribed by the procedure, and that communications between shift personnel are affected.

4.1.3 Modify the portion of procedure PRP-OP-009 to eliminate the Plant Shift Manager's authority to make temporary changes that compromise plant protective features. Temporary changes that impact safety, environment, health, or regulatory compliance should be reviewed by staff experts in those areas and approved by senior line management. Delegation of this authority should not go below the Plant Operations Manager.

4.1.4 Improve the content, scope, comprehensiveness and safety of SOPs, Contingency Procedures and Non Normal Procedures to minimize the use of the Plant Shift Managers authority to deviate from these procedures to those situations requiring emergency actions for safety. Elimination of the need for this authority should be the goal of an effective procedures system. Start with those SOPs involved with the operation of the DFS and PAS systems.

4.1.5 Transfer all procedural direction from the Operational Management Memorandum (OMM) program into the appropriate, related SOPs and do not allow the use of the OMM program for procedural direction of operations.

4.1.6 Review all SOPs for comprehensiveness and sufficient detail to ensure the safe and proper operation of the plant if used by the operators. Correct the deficiencies noted in specific procedures as detailed in the Conclusions section. Start with those SOPs involved with the operation of the DFS and PAS systems. Use Appendix C as the standard for developing operational procedures.

4.1.7 Provide contingency procedures to assist shift management and operators in recovery of the plant from frequently experienced or probable plant upset conditions, loss of key plant/system components and events.

4.1.8 Improve the rigor and function of the Document Control System so that all documents in use are the most current revision. Ensure that all SOPS, Contingency Procedures and Non Normal Procedures in the Control Room are the latest revision as a procedural restart requirement for the DFS and PAS systems.

4.1.9 Insert a caution in the DFS operating procedure against using the scrubber tower mist eliminator pad spray to add make up water during high flow conditions to prevent moisture carryover.

4.1.10 Develop, implement, and train all personnel in the use of a clearly defined, hierarchical listing of procedures. Reference this hierarchy of documents in all procedures as appropriate.

4.1.11 Track correction progress on corrective action determined as a result of event investigations by using the existing Deficiency Reporting (DR) tracking system. Have existing PLL staff review the PLL and CDOM and provide input to the DR system to track review and/or implementation of applicable findings using corrective actions within the DR system. Involve QA and Safety personnel in validating corrective action where appropriate.

4.2 Training

4.2.1 Procure and install a DFS furnace and PAS system training simulator to ensure the on site capability to conduct comprehensive site specific DFS Furnace and PAS systems training in both normal and non normal conditions. The simulator should be capable of establishing probable non-normal and upset conditions and allow recovery from these upset conditions. Further the simulator should provide the capability to impose component malfunctions and failures and allow plant and equipment recovery actions.

4.2.2 Review the Lessons Learned from this event with all shift operations personnel and line management in a seminar type approach. Include the Narrative Timeline, the notes from the taped discussion of the DFS furnace and PAS system diagram with annotated times and changing plant parameters and the system diagram itself in this training.

4.2.3 Augment the General Managers current management oversight programs by increasing the participation of responsible line and functional managers for operation of the Chemical Agent Disposal Facility. The program should include monitoring visits to the plant and control room to observe and evaluate the knowledge and proficiency level of plant operators, their management of the work load and plant status, use of procedures and procedural compliance with special emphasis on correcting the knowledge and operating deficiencies noted in this investigation. The visits should be both scheduled and random and frequently cover night and weekend shifts.

4.2.4 Ensure all line managers are current in the training and qualification certifications required for their positions as soon as practicable after assignment to enhance their plant knowledge.

4.2.5 Provide special training for all operations personnel on new and revised procedures developed as a result of corrective action related to this event.

4.2.6 Add a feature to the current training program to evaluate shift operators' level of knowledge of plant equipment, systems and their interrelated function and the operators' functional proficiency as an element of their biennial recertification, and, at least, mid way between biennial recertifications.

4.2.7 Add a training program feature to formalize the structure of on-shift training. Include seminars on operations, formal lectures to reinforce the knowledge of plant fundamentals and operating dynamics and, finally, review of the lessons learned from this and other plant events and upsets and related pertinent PLL program Lessons Learned. Reviews of pertinent TOCDF Plant Lessons learned and PLL Lessons Learned should be included during refresher training as well as on shift training periodically and following each event.

4.3 Engineering Equipment and Systems

4.3.1 Install an effective means to promptly isolate the kiln from the after burner as a barrier to mitigate potential agent vapors entering the DFS/PAS from the ECR. This should be able to be manually operated remotely from the DSF Operators computerized control console and have two states, either fully open or fully closed.

4.3.2 Replace the current Kurz flow measurement device and system with a system that is not affected by water. Alternatively, acquire a redundant means of measuring flow and providing protective system features with other flow measurement devices currently installed in the system (such as the refractory ring).

4.3.3 Provide an engineering solution which ensures that residence time for the flue gases is not reduced below the 2 second alarm point without the kiln isolation value closed.

4.3.4 Provide a lighted and interactive furnace system schematic on a large display conveniently available to the CRO that shows major components and control status or a single screen display on the operators CRO's console showing major components, their controls, and measured parameters and their status.

4.3.5 Modify the Scrubber Tower Clean Liquor Re-Circulation system to improve the efficiency of the system and provide sufficient make up feed through the re-circulation system so that required sump levels can be maintained without excessive operator intervention and moisture carry over through use of the mist elimination pad spray process water feed makeup feed.

4.3.6 Conduct a study to determine the relationship between residence time and kiln and Afterburner temperature to ensure total agent vapor incineration. Prepare an appropriate guide for Control Room Operators, Control Supervisors and Plant Shift Managers.

4.3.7 Modify the ACAMS 702 alarm and sensing system so that caustic moisture carry over does not impair or delay its proper and timely function.

4.3.8 Determine if it is reasonable to upgrade the DFS and PAS control systems to automatically return the system to normal operating conditions following an upset or establishment of a non-normal condition.

4.3.9 Modify the DFS furnace feed chute to eliminate the need to clean out the chute manually.

4.4 EG&G Corporate

4.4.1 EG&G Corporate should provide a team experienced in complex plant operations to review the status of corrective action on a periodic basis. This team will monitor and evaluate operators conducting plant operations as well as review training, procedures, technical documentation and document control.

APPENDIX A – NOTIFICATION TIMELINE FOR MAY 8th & 9th, 2000 EG&G INVESTIGATION INTO THE CHEMICAL AGENT DISCHARGE AT THE TOOELE CHEMICAL AGENT DISPOSAL FACILITY

2326

- PAS 701C alarmed at 0.67 ASC.
- Control Room Supervisor notified.
- Plant Shift Manager notified.
- Shift Safety Representative notified.
- Shift Environmental Representative notified.
- Sounded Agent Alarm and masked the site.

2327

- QASAS notified.
- EOC notified.
- Monitoring Lead notified.

2328

- PAS 701A alarmed at 1.57 ASC.

2329

- PAS 701C at 1.32 ASC.
- Preliminary classification made as AL 1.

2331

- PAS701A at 2.52 ASC.
- Monitoring updated on status.
- Perimeter lights activated.

2332

- PAS701C at 1.88 ASC.

2334

- PAS701A at 2.84 ASC.

2335

- PAS701 at 2.30 ASC.

2337

- PAS701A at 3.24 ASC.

2338

- PAS701C at 2.90 ASC.

APPENDIX A – NOTIFICATION TIMELINE FOR MAY 8th & 9th, 2000 EG&G INVESTIGATION INTO THE CHEMICAL AGENT DISCHARGE AT THE TOOELE CHEMICAL AGENT DISPOSAL FACILITY

2340
- PAS701A at 3.40 ASC.

2341
- PAS702 alarmed at 1.45 ASC (first time).
- PAS701C at 3.64 ASC.
- JT Thorpe sent to PMB Lunchroom.

2343
- PAS701A at 3.38 ASC.

2344
- PAS702 at 0.61 ASC.
- PAS701C at 2.06 ASC.

2346
- PAS701A at 3.38 ASC.

2347
- PAS702 at 0.69 ASC.
- PAS701C at 0.69 ASC.

2348
- JT Thorpe accounted for.

2349
- PAS701A at 0.37 ASC.

2350
- PAS702 at 0.75 ASC.
- PAS701C at 0.24 ASC.

2352
- PAS701A at 0.10 ASC – alarm cleared.
- Safety, Environmental and QASAS notified.

2353
- PAS702 at 0.65 ASC.
- PAS701C at 0.07 ASC – alarm cleared.
- Safety, Environmental and QASAS updated.

APPENDIX A – NOTIFICATION TIMELINE FOR MAY 8th & 9th, 2000 EG&G INVESTIGATION INTO THE CHEMICAL AGENT DISCHARGE AT THE TOOELE CHEMICAL AGENT DISPOSAL FACILITY

2355
- EOC updated.

2356
- PAS702 at 0.55 ASC.

2359
- PAS702 at 0.40 ASC.

0002
- PAS702 at 0.28 ASC.

0005
- PAS702 at 0.23 ASC.

0008
- PAS702 at 0.18 ASC alarm cleared.

0011
- PAS702 at 0.13 ASC.

0014
- PAS702 at 0.11 QAC.

0017
- PAS702 at 0.09 ASC.

0018
- Unmasked the site.

0029
- PAS701B alarmed at 0.39 ASC.
- PAS702 alarmed at 0.86 ASC.
- Safety, Environmental and QASAS notified.

0030
- PAS701C alarmed at 0.56 ASC.
- EOC notified.

APPENDIX A – NOTIFICATION TIMELINE FOR MAY 8th & 9th, 2000 EG&G INVESTIGATION INTO THE CHEMICAL AGENT DISCHARGE AT THE TOOELE CHEMICAL AGENT DISPOSAL FACILITY

0031

- PAS701B at 0.74 ASC.

0032

- PAS701C at 0.81 ASC.

0034

- PAS701B at 0.61 ASC.

0035

- PAS701C at 0.30 ASC.
- PAS702 at 0.31 ASC
- JT Thorpe at PMB Lunchroom.

0037

- PAS701B at 0.20 ASC.

0038

- PAS701C at 0.02 ASC alarmed cleared.
- PAS702 at 0.28 ASC.

0040

- PAS701B at 0.05 ASC alarm cleared.

0041

- PAS702 at 0.23 ASC.

0044

- PAS702 at 0.25 ASC.

0047

- PAS702 at 0.24 ASC.

0050

- PAS702 at 0.24 ASC.

0053

- PAS702 at 0.21 ASC.

APPENDIX A – NOTIFICATION TIMELINE FOR MAY 8th & 9th, 2000 EG&G INVESTIGATION INTO THE CHEMICAL AGENT DISCHARGE AT THE TOOELE CHEMICAL AGENT DISPOSAL FACILITY

0056

- PAS702 at 0.18 ASC alarm cleared.

0057

- PAS701 DAAMS tube confirmed agent.

0059

- PAS702 at 0.17 ASC.

0102

- PAS702 at 0.15 ASC.

0103

- Plant Shift Manager re-classified event to AL 4.
- QASAS notified.

0104

- PAS702 at 0.11 ASC.

0107

- PAS702 at 0.09 ASC.
- Unmasked the site.

0108

- Environmental Compliance Manager notified.

0111

- Safety Manager notified.

0115

- DGM – Risk Management notified.

0131

- DGM – Plant Operations notified.

0138

- Operations Manager notified.

0230

- PAS701 DAAMS tube confirmed agent on 0028 alarm.

APPENDIX A – NOTIFICATION TIMELINE FOR MAY 8th & 9th, 2000 EG&G INVESTIGATION INTO THE CHEMICAL AGENT DISCHARGE AT THE TOOELE CHEMICAL AGENT DISPOSAL FACILITY

0300

- DSHW notified – answering machine.

0400-0430

- DCD Civilian Executive Assistant on-site.
- PMCD Assistant Project Manager, Operations, Compliance and Monitoring on-site.
- EG&G DGM-Risk Management on-site.

0800

- DSHW notified via conference call with PMCD and EG&G.

APPENDIX B – ANALYTIC TECHNIQUE SYNOPSIS EG&G INVESTIGATION INTO THE CHEMICAL AGENT DISCHARGE AT THE TOOELE CHEMICAL AGENT DISPOSAL FACILITY

Kepner-Tregoe (K-T) is a proprietary methodology for problem and decision analysis. This methodology was used to determine and document the direct and root causes, as well as to identify corrective actions, for the May 8 accident. K-T analysis forms a structured guide for the accident investigation. In complex events, the K-T process can be used to verify and document investigation logic.

Management Oversight and Risk Tree (MORT) is a comprehensive analytical procedure that provides a disciplined approach for determining the causes and contributing factors of an accident. The MORT logic diagram displays the structured set of interrelated safety program elements and concepts comprising the ideal management model. The universal logic diagram becomes a master "worksheet" for use in analyzing a specific accident. The MORT logic diagram is an idealized safety system model based upon fault tree analysis. In a "perfect" system, all components function in a manner that contributes to task achievement. In an imperfect system, some "fault" exists. Within the MORT system, an accident is defined as Barrier/Control inadequacy in which an unwanted flow of energy results in adverse consequences. MORT suggests that an accident is usually multifactorial in nature. It occurs because of lack of adequate barriers and/or controls upon the unwanted energy transfer. MORT logic was used as one tool to analyze the May 8 accident at TOCDF. Instead of a complete MORT analysis, the investigators used the MORT scheme to determine whether any significant factor was being omitted.

APPENDIX C – OPERATIONS PROCEDURES EG&G INVESTIGATION INTO THE CHEMICAL AGENT DISCHARGE AT THE TOOELE CHEMICAL AGENT DISPOSAL FACILITY

1) INTRODUCTION

Operations procedures are written to provide specific direction for operating systems and equipment during normal and postulated abnormal and emergency conditions.

Operations procedures should provide appropriate direction to ensure that the facility is operated within its design basis and should be effectively used to support safe operation of the facility. Other methods of disseminating operational information include Operator Orders, and Operator Aids.

2) DISCUSSION

Procedures are a key factor affecting operator performance. Appropriate attention should be given to writing, reviewing, and monitoring operations procedures to ensure the content is technically correct and the wording and format are clear and. Although a complete description of a system or process is not needed, operations procedures should be sufficiently detailed to perform the required functions without direct supervision. Consistency in procedure format, content, and wording is essential to achieve a uniformly high standard of operator performance. Operators should not be expected to compensate for shortcomings in such procedures as poor format or confusing, inaccurate, or incomplete information. Instead, procedures should be written in such a way that they can be easily used without making mistakes.

During the course of operations, technical and operational requirements change and better ways of doing things develop. To ensure that procedures in use provide the best possible instructions for the activity involved, periodic review and feedback of information are essential. The facility policy on use of procedures should be clearly understood by all operators. Properly controlled and readily available procedures promote use and ensure that operational activities will be conducted in the manner intended.

APPENDIX C – OPERATIONS PROCEDURES
EG&G INVESTIGATION INTO THE CHEMICAL AGENT DISCHARGE AT THE TOOELE CHEMICAL AGENT DISPOSAL FACILITY

3) GUIDELINES

a) Procedure Development. To ensure consistency among operations procedures, the methods for developing new procedures, including procedure formats, should be clearly defined. Administrative procedures and/or writers' guides should direct the development and review process for procedures.

Procedures should be developed for all anticipated operations, evolutions, tests, and abnormal or emergency situations. Annunciator/alarm response procedures that guide the operator in verifying abnormal conditions or changes in plant status and provide the appropriate corrective action should be developed for all alarm panels. All procedures should provide administrative and technical direction to conduct the intent of the procedure effectively. The extent of detail in a procedure should depend on the complexity of the task, the experience and training of the user(s), the frequency of performance, and the significance of the consequences of error.

Procedure preparation, verification, and validation should receive high-level attention. Qualifications for procedure writers should be considered, including operating organization and experience. Review, verification, and validation should be formalized for written and software procedures.

b) Procedure Content. To provide uniformity in operations procedures, the content of procedures should conform to prescribed guidelines. The procedure aspects described below should be followed when developing operations procedures:

(i) The scope and applicability of individual procedures should be readily apparent. Procedures with single-unit applicability should be distinctively identified to avoid confusion with sister-unit procedures. In addition, to enhance rapid retrieval, emergency procedures should be distinguishable from other procedures. Color coding could be used for these purposes.

(ii) Procedures should incorporate appropriate information from applicable source documents, such as the facility design documents, safety analysis documents, and vendor technical manuals.

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EG&G INVESTIGATION INTO THE CHEMICAL AGENT DISCHARGE AT THE TOOELE CHEMICAL AGENT DISPOSAL FACILITY

(iii) Prerequisites and initial conditions should be detailed. Careful consideration should be given to the location of this information within the procedure in order to help ensure that the intent of the procedure is understood. In addition, any hoses, tools, or other temporary testing equipment should be verified operable, calibrated, or inspected and in good condition where possible, before implementing any test procedure, to ensure that they function as expected during the test. These verifications should be identified in the prerequisite section, with completion sign-offs required. "Hold" points (requiring independent verification and/or approval) should be clearly delineated.

(iv) Definitions used in the procedure should be explained.

(v) Procedures should be easily understood, and actions should be clearly stated.

(vi) Procedures should contain only one action per step.

(vii) Procedures should contain sufficient but not excessive detail. The skill level, experience, and training of the users should be considered.

(viii) Warnings, notes, and cautions should be easily identifiable and should not contain action statements. The probability of missing an action step increases when it is included in a warning, note, or caution.

(ix) Warnings and cautions should precede the step to which they apply. Warnings, notes, and cautions should appear on the same page as the step to which they apply. This ensures that operators are alerted to necessary information before performing a procedural step.

(x) Procedures should be technically and administratively accurate (i.e., the instructions and information should be correct; referenced documents should be correctly identified; and necessary instructions should be present to guide the user when transferring between procedures).

(xi) Individual sign-offs should be provided for selected critical steps. One sign-off should not be applied to more than one action.

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(xii) Limits and/or tolerances for operating parameters should be specified and should be consistent with the readable accuracy of instrumentation. Operators should not be required to perform mental arithmetic to determine if a specified parameter is acceptable.

(xiii) Acceptance criteria for surveillance or test procedures should be easily discerned, including tolerances and units. If calculations are needed to compare data to acceptance criteria, the calculations should be clearly explained.

(xiv) Sequence of procedural steps should conform to the normal or expected operational sequence. Training on this sequence, reinforced with procedures that show the same sequence, will serve to improve operator performance by development of patterns of action that are more easily remembered.

(xv) Procedures should be developed with consideration for the human-factor aspects of their intended use. For example, references to components should exactly match drawing and label-plate identifiers, units should be the same as those marked on applicable instrumentation, and charts and graphs should be easily read and interpreted. Important factors (such as operating limits, warnings, cautions, etc.) should be highlighted.

(xvi) Emergency operating procedures should provide guidance in responding to single and multiple casualties.

(xvii) Portions or steps of other procedures that are used or referred to when performing a procedure should be specifically identified within the procedure so that operators will not be confused when transferring between procedures.

(xviii) Component or system shutdown and restoration requirements following shutdown or a surveillance or test activity should be specific and controlled by the procedure.

c) Procedure Changes and Revisions. Procedure changes and revisions are necessary to ensure that procedures reflect current operating practices and requirements. The review and approval process for each procedure change or revision should be documented. For the purpose of these guidelines, a "procedure change" refers to an on-the-spot change (whether for permanent or for one-time-only use). Procedure changes do not involve retyping or reissuing a procedure. "Procedure revisions" constitute a new, retyped edition of the procedure. Procedure changes and revisions should conform to the following practices:

(i) Procedure changes intended for use more than one time should be documented in a location readily available for operator reference. To avoid the possibility of error, these changes should also be referenced in procedure copies used by operators.

(ii) Appropriate procedure changes and revisions should be initiated when procedure inadequacies or errors are noted.

(iii) Procedure revisions should be initiated when a change has been outstanding for an extended period (e.g., greater than 6 months) or when a procedure has been affected by several changes (e.g., more than five). All currently effective procedure changes should normally be incorporated when the procedure is revised.

(iv) Procedure revisions should be implemented concurrently with modifications. Procedure updates required by temporary modifications should be handled as procedure "change" and implemented concurrently with the temporary modification installation.

(v) Important information regarding changed or revised procedures should be communicated to appropriate operations personnel via the required reading system (Chapter XIV), a pre-shift briefing, or a similar method.

(vi) Documentation of the reason for key procedure steps should be maintained and reviewed when implementing changes or revisions that alter these steps. This practice is important to ensure that the reason for any step is not overlooked.

(vii) The review process should involve verification and validation of the procedure using walkthroughs or similar methods.

APPENDIX C – OPERATIONS PROCEDURES
EG&G INVESTIGATION INTO THE CHEMICAL AGENT DISCHARGE AT THE TOOELE CHEMICAL AGENT DISPOSAL FACILITY

d) Procedure Approval. Operating procedures should be approved by the Plant Operations Manager. In addition, procedures that affect safety-related equipment and emergency procedures should be reviewed by the facility safety review committee or by another appropriate review mechanism. Procedure revisions should receive the same depth of review and level of approval as the initial versions. New and revised procedures should be approved prior to use.

e) Procedure Review. New and revised operations procedures should be reviewed prior to issuance and at periodic intervals to ensure that the information and instructions are technically accurate and that appropriate human-factor considerations have been included. The frequency of subsequent reviews should be specified; it may vary with the type and complexity of the activity involved and with time as a given plant reaches operational maturity. Applicable procedures should be reviewed after an unusual incident (such as an accident, an unexpected transient, significant operator error, or equipment malfunction). During reviews, procedures should be compared to source documents to verify their accuracy. In addition, new procedures should be validated by walk-throughs in the facility or by operation on a facility-specific simulator to ensure workability.

f) Procedure Availability. A controlled copy of all operations procedures should be maintained in the control area for operator reference, and selected controlled procedures should be maintained at other appropriate locations. For example, controlled procedures for facility shutdown from outside the control area should be maintained at the remote shutdown location(s). It may be desirable to have procedures for routine evolutions available at local work stations.

Working copies of controlled procedures should be available for use during evolutions. However, since these documents have only a limited lifespan, working copies should be controlled and a system should be in place to ensure that outdated procedures are not used by mistake and that working copies are replaced according to approved procedures. For example, uncontrolled working copies could be verified by comparison to a controlled copy prior to use.

Controlled annunciator response procedure information should be easily accessible to the operators responsible for responding to alarms. Some facilities can provide annunciator response procedures at local control panels. If this is not done, annunciator response procedures should be provided at an alternate location convenient to the equipment operator.

APPENDIX C – OPERATIONS PROCEDURES
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g) Procedure Use. Facility operation should be conducted in accordance with applicable procedures that reflect the facility design basis. The requirements for use of procedures should be clearly defined and understood by all operators. If procedures are deficient, a procedure change should be initiated. In exception to this policy, operators may take whatever action is necessary during emergency conditions to place the facility in a safe condition, and to protect equipment, personnel, and public safety without first initiating a procedure change.

Operators should have procedures with them and follow them in a step-by-step manner when the procedures contain sign-offs for the various activities. In addition, procedures should be referenced during infrequent or unusual evolutions when the operator is not intimately familiar with the procedure requirements or when errors could cause significant adverse impact to the facility. Operators need not reference emergency procedures during the performance of immediate actions since these actions, are committed to memory; however, the emergency procedure immediate action instructions should be reviewed after the actions are performed, thus, verifying, that all required actions have been taken.

APPENDIX D – OPERATION ANALYSES
EG&G INVESTIGATION INTO THE CHEMICAL AGENT DISCHARGE AT THE TOOELE CHEMICAL AGENT DISPOSAL FACILITY

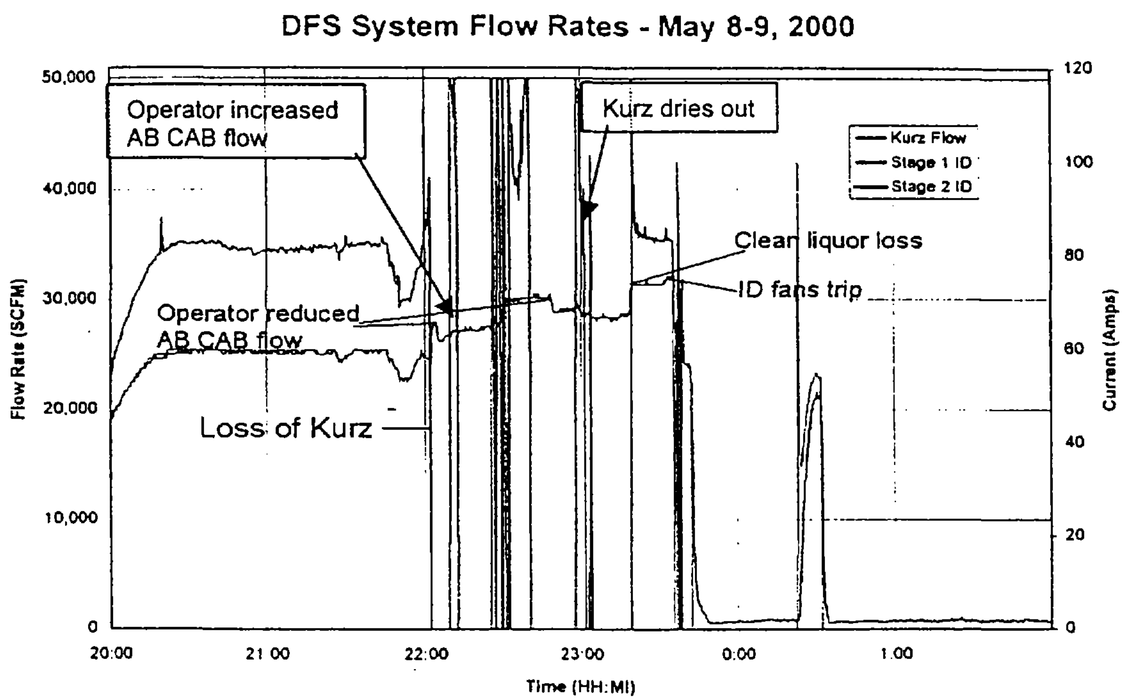

FIGURE 1.

Figure 1 depicts flow rate on May 8, 2000 starting at 2000 until 0200 the next morning. The ID fan current is also shown. The original intent of the memorandum OMM-005 was to establish a differential pressure between the ECR and the kiln to keep hot material from migrating into the ECR during DPE entry. To lower the pressure in the kiln, the operator increases flow through the system by opening the ID fan damper. He can do this by changing the kiln pressure controller setpoint, or by taking direct control of the ID damper. The amount of flow necessary to achieve the -1.5 in WC pressure in the kiln required almost double the flow of a normal operation, nearly 36,000 SCFM compared to about 18,000 SCFM earlier in the day.The increased flow had several consequences. Carryover from the scrubber to the demister increased leading to loss of liquor in the scrubber. In turn this led to a low sump alarm that prompted the operator to add process water as he had done before in other low sump situations. However, the high flow entrained additional process water and bathed the Kurz meter. It malfunctioned and the BMS secured fuel to the burners. High flow reduced residence time in the after burner below two seconds and also reduced pressure in the kiln. The loss of clean liquor at about 2320 had the effect of increasing ID fan current and drying out the Kurz meter. An interesting feature in figure 1 is that the ID fan current continued to increase while the Kurz meter was inoperative due most likely to the amount of moisture that was carried over to the fans. Also the effect of AB CAB operation on fan current during the failed purge attempt between 2229 and 2249 is clearly evident.

APPENDIX D – OPERATION ANALYSES
EG&G INVESTIGATION INTO THE CHEMICAL AGENT DISCHARGE AT THE TOOELE CHEMICAL AGENT DISPOSAL FACILITY

DFS Afterburner Temperature and Stack ACAMS Readings – May 8-9, 2000

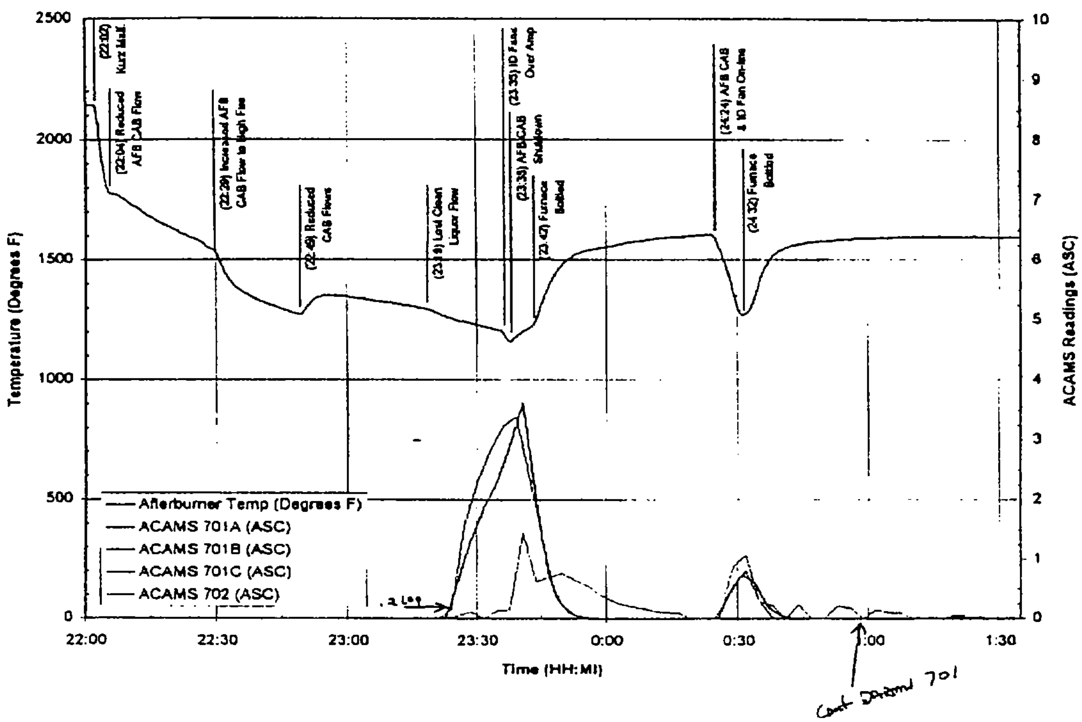

FIGURE 2.

Figure 2 depicts the after burner temperature as a function of time between 2200 and 0130. The stack and DFS ACAMS data are plotted against the same time period. Significant operator actions and events are identified at discrete times. The after burner temperature drips rapidly when burners are secured, then more slowly as AB CAB air is reduced. This marks the loss of the design engineered barrier to agent release, gas temperature above 2050 degrees Farenheit and residence at that temperature for at least two seconds. The failed restart effort is again obvious. When clean liquor is lost at about 2220, agent begins to exit the stack. The stack ACAMS sample the flue gases for three minutes then checks for agent. At about 2223, agent begins to register on the stack ACAMS and exceeds alarm levels after the next three minute read cycle. Levels climb until ID fans trip on overcurrent and the flow stops. The delay in the DFS ACAMS reading (702) was caused by caustic from carry over. The caustic was drawn into the ACAMS probe and neutralized agent in the air sample before it registered. As the agent flow continued, it finally overpowered the carry over caustic and began to register. The long tail on the plot for 702 was due to monitors challenging the ACAMS.

With the decision to relight the Afterburner, an ID fan is started at 0024 and one AB CAB is started. Agent is again drawn through the DFS and sent up the stack with the resultant ACAMS alarms. The ID fan is secured and flow stopped at about 0032. The ACAMS continues to draw agent out of the flue for 702 and the stack for 701 reading the presence of agent on a three minute cycle time until none remains.

Identifying the specific circumstances that allowed agent to exit the stack required a source of agent. ECR-B ACAMS readings while processing rockets on the day shift were often in excess of 4.0 MPL but were less than 0.4 MPL during the release. However, the residue from cleaning the strainers remained on the slide gate and was a significant source of agent vapor. The strength of the source term was apparently lost on the CRS who did not understand that 1 MPL is equivalent to 500 IDLH or 1,000,000 TWA. The room itself was a significant agent source.

APPENDIX D – OPERATION ANALYSES
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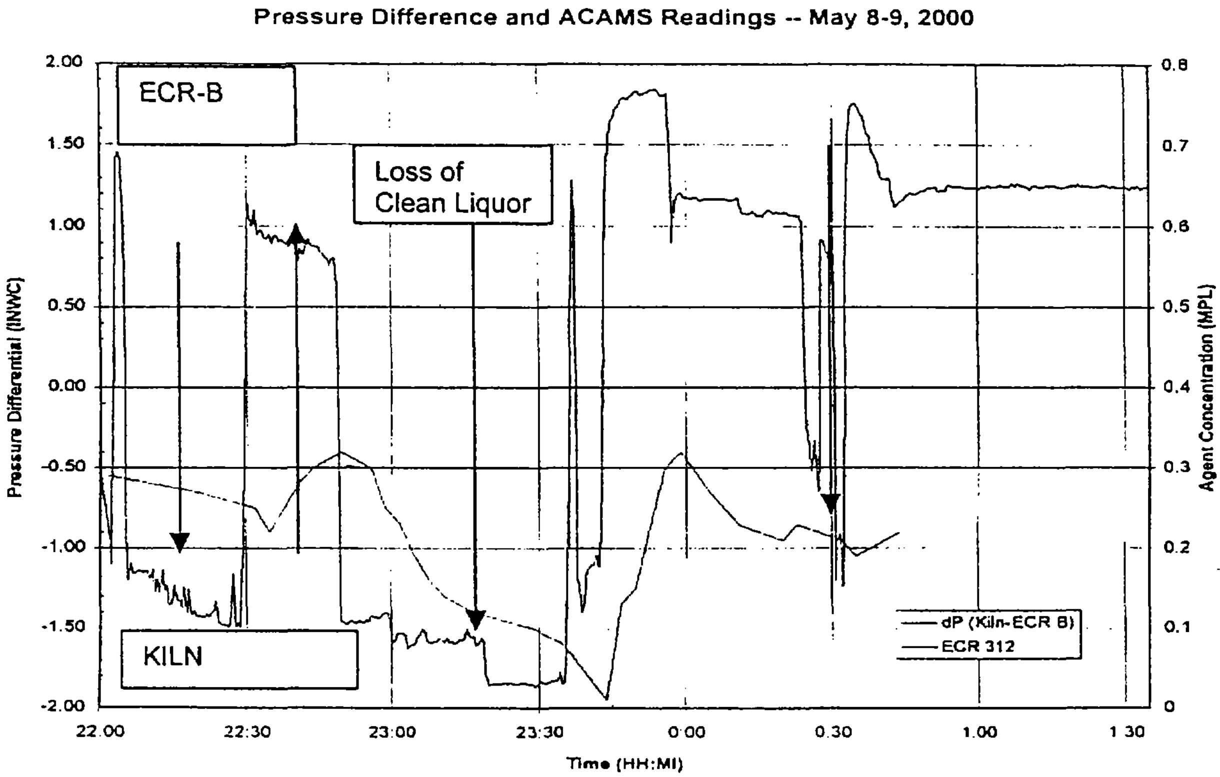

FIGURE 3.

Figure 3 plots the differential pressure between the kiln and the ECR-B for the same period as figure 2. The ECR ACAMS data is also depicted as well. When the differential pressure is negative, agent vapor flows from the ECR into the kiln around the gates and through the chute. When the pressure is positive, flue gases flow from the kiln toward the ECR up the chute. This differential appears to be very sensitive to AB CAB flow at this high flue gas flow rate. At 2230, the AB CAB flow is increased to purge for a relight attempt and the differential pressure shifts from -1.5 to +1.0, then returns to -1.5 when the AB CAB airflow is reduced at 2249. In this condition, agent vapor is drawn into the DFS from the ECR under very high flow conditions with no burners on line. Agent at some significant concentration gets through the kiln, after burner, quench tower, and is neutralized in the scrubber until clean liquor flow is secured by the operator. At that point, agent is drawn through the rest of the system and sent up the stack. Agent concentration in the ECR is significantly reduced when the differential pressure is negative consistent with removing agent from the room through the DFS chute. When the pressure is positive, agent is drawn through the ECR ventilation system past the ACAMS and the indicated concentration increases.

EG&G

ADDENDUM #1
TO
EG&G INVESTIGATION
INTO THE
CHEMICAL AGENT DISCHARGE
AT THE
TOOELE CHEMICAL AGENT DISPOSAL FACILITY

May 15-26, 2000

John M. Kersh, Chairman
EG&G Investigation Team

Date: June 16, 2000

EG&G

Since forwarding the report on June 9, 2000, additional information has been developed and some errors or needs for clarification have been noted; therefore, please make the following changes for the reasons listed and preceding each change.

Reason: The exact amount of chemical munitions GB Agent released has come under question and is being evaluated and recalculated by independent outside experts since standard flows, temperatures and pressures instead of actual flows temperatures and pressures were used in the initial calculation. The General Manager of EG&G Defense Materials has prepared a special letter addressing the issue. The release quantity will not be published until the evaluation and recalculations are complete.

Change:
Page 3, first paragraph, first line; delete "18 milligrams of".

Page 5, **Introduction 1.0 Background,** first paragraph, first line; delete "approximately 18 milligrams of".

Page 22, **2.9 Safety,** Change the first paragraph to read "An engineering analysis to determine the amount of agent released was performed using ACAMS 701 readings on May 8 from 23:26 to 23:52 and on May 9 from 00:28 to 00:56. The quantity determined has been questioned since its calculation was based on standard rather than actual flows, temperatures and pressures. The quantity is being evaluated and recalculated by independent outside experts. ACAMS 701 C readings of 3.63 and 0.81 "Allowed Stack Concentration (ASC)" will be used respectively for the calculations in the two time periods involved. The release quantity will not be published until the evaluation and recalculations are complete."

Reason: Correct Technical Information and Nomenclature.

Change:
Page 3, third paragraph, third line: change "250°" to "175°" and "separator" to "scrubber".

EG&G

Reason: The high frequency of ACAMS alarms tended make operators and supervisors think the alarms were false.

Change:
Page 16, second paragraph from the top of the page. Delete the paragraph and substitute the paragraph below:

"In the 96 days from January 1, 2000 to April 5, 2000, there were 197 ACAMS alarms, and 80 of these were false positive alarms. The period between September 1999 and December 1999 had an even higher rate of ACAMS alarms. Although the majority of these alarms were due to equipment malfunction, testing or training, when taken together with the false positive alarms, they tend to condition the operators and supervisors to expect the alarm to be in error. The report from the monitor who evaluated the first 701 ACAMS alarm to the CRS was misinterpreted by the CRS who considered that the report confirmed a typical, false alarm."

Reason: To clarify the statements on the control room teams' required reading and the position of the Operations Supervisor, who is not a member of the control room team, and his required reading.

Change:
Page 17, first paragraph at the top of the page; delete the a current paragraph and insert the paragraph below:

"Further, each member of the control room team was current in required reading. The Operations Supervisor is not part of the control room team, but was responsible for the DPE entry into ECR associated with the DFS and his required reading included the DFS SOP. The Operations Supervisor had not read SOP-004 Revision 4 Change 0 or SOP-004 Revision 4 Change 1. Accordingly, the Operations Supervisor was not aware of any impact on his DPE entry of those changes to the DFS SOP."

EG&G

Reason: To clarify paragraph 3.1.28 concerning the lessons learned program and investigation issue tracking and closure.

Change:
Page 28, paragraph 3.1.28; delete the current paragraph and add the paragraph below:

"Two procedures, PRP-MG-013, and PRP-MG-014 specify requirements for reporting, performing investigations and tracking corrective actions for all events on the site. A separate procedure, PRP-SA-002, Accident Investigation and Recording, also requires investigation reporting and corrective action tracking. The current practice is to use both procedures and two separate reporting, investigating and tracking systems. This increases the risk of not adequately reporting, investigating and following up on all corrective actions from events because of the multiple tracking and closure systems. In addition, there is no documented evidence that lessons learned from either the Chemical Demilitarization Operations Manual (CDOM) or the Program Lessons Learned (PLL) have been implemented at TOCDF. Both programs have issues/items that have a direct bearing on this event. There are two documents that govern the Programmatic Lessons Learned at the site, the Site Programmatic Lessons Learned Program Plan (PMCD document) and the Programmatic Lessons Learned Implementation Plan (EG-065, Rev 2). Both documents contain specific lessons learned reports. Further, a review of the lessons learned identified several that are directly applicable to this agent release event and would have mitigated or possibly even prevented the event. Accordingly, the conclusion is that these lessons learned and their inherent preventive measures have not been effectively implemented in the training program in formal classroom training or in on shift training at the TOCDF."

Reason: Frequent false positive and other ACAMS alarms due to maintenance, training, testing, etc. have tended to make operators and supervisors hesitant to believe the alarms.

Change:
Page 35; add to recommendations:

4.3.10 Conduct a study, locate or develop and provide a chemical munitions agent sensing and alarm system that will experience significantly fewer false positives and be just as sensitive to detecting agent concentrations.